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A STUDY OF THE EFFECTIVENESS, FEASIBILITY, AND RESOURCE REQUIRE--ETC(U)
JAN 77 J A HUGHES, J P HYMES N61339-75-C-0100
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A STUDY OF THE EFFECTIVENESS, FEASIBILITY, AND RESOURCE REQUIREMENTS OF INSTRUCTIONAL SYSTEMS DEVELOPMENT: EA-6B READINESS TRAINING

COURSEWARE, INCORPORATED, SAN DIEGO, CALIFORNIA

JANUARY 1977

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A STUDY OF THE EFFECTIVENESS, FEASIBILITY, AND RESOURCE REQUIREMENTS OF INSTRUCTIONAL SYSTEMS DEVELOPMENT: EA-6B READINESS TRAINING

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FINAL REPORT FOR PERIOD APRIL 1975 - APRIL 1976

JANUARY 1977

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This project was one of four aircrew training development projects sponsored by the Naval Training Equipment Center (NAVTRAEQUIPCEN) in a continuing study of the methodology, effectiveness, and resource requirements of Instructional Systems Development (ISD). It was a Phase I effort, covering ISD phases through lesson specification. Project goals were to study the effectiveness, feasibility, and resource requirements of full-scope ISD, and to support the Replacement Aircrew Training Squadron in its training program

Block 20

development efforts. First, project goals, assets, and constraints were determined. A task listing of the two crew positions was performed. The listing was validated on operational squadron members through a survey, which also provided data used to select tasks to be trained. Tasks were analyzed into a hierarchical structure of supporting skills and knowledges, which served as the basis for formulation of instructional objectives. Objectives were organized and sequenced, and alternative media selected for each lesson. Resource requirements were calculated for four alternative media mix plans to aid in resource planning for later development and implementation. Lesson specifications (detailed instructional development blueprints) were begun for the 1186 objectives, but were not completed due to a shortage of subject-matter experts. It was concluded that the ISD model used was feasible and sufficiently prescriptive for standardized employment. Data on personnel requirements were gathered and processed into a table for estimating personnel requirements in future projects. Recommendations were made for modifications to the basic ISD model and procedures, and for improved ISD implementation methods.

SUMMARY

This project represented an attempt to collect data on the effectiveness, feasibility, and resource requirements of Instructional Systems Development (ISD) in the context of an operational Navy aircrew training environment. This was one of four aircrew training development projects sponsored and directed by the Naval Training Equipment Center. It took place at the Naval Air Station, Whidbey Island, the location of the Replacement Aircrew Training Squadron for the EA-6B aircraft. The EA-6B project was a Phase I effort, covering ISD steps from Job Analysis through Lesson Specification. ISD expertise was provided by the Contractor. Subject-matter expertise was provided by Training Squadron personnel.

An initial problem analysis was conducted to determine specific project goals and to document existing and anticipated training assets and limitations. Following this, six major ISD steps were carried out.

JOB ANALYSIS

This phase consisted of two major activities.

TASK LISTING. For each of the aircrew positions of the EA-6B (ICAP) aircraft, a list of major job tasks was developed. The primary input was made by experienced Navy subject-matter experts (SME), using the Contractor's task listing algorithm.

JOB ANALYSIS SURVEY. A job analysis survey was developed and distributed to all experienced EA-6B aircrew members. The results of this survey were later used to select tasks for training.

SELECTION OF TASKS FOR TRAINING

Based on the job analysis survey, three categories of tasks were selected for the ICAP training program. These were (1) full-scale training, (2) review only, and (3) familiarization only.

OBJECTIVES HIERARCHY DEVELOPMENT

Selected tasks were further analyzed. Subtasks were identified, and behavioral objectives developed for each of these supporting elements. The objectives were arranged in hierarchy format to show their interrelationships. Primary input came from Navy SME, using Contractor's methodology and training.

COURSE SEQUENCING AND GROUPING

Based on the structure of the hierarchies, the objectives were sequenced and grouped into units, lessons, and segments. There were 1186 segments identified. Sets of lesson maps were developed which formed a definitive syllabus for each of the courses. This phase was conducted by Contractor personnel, with content and scheduling inputs provided by Navy SME.

MEDIA SELECTION

Initial media selection was made for each objective. It employed a computerized algorithm which sorted objectives into media categories based on the type of behavior and content, basic display requirements, and other learning-related variables. Optimal and alternative presentation media were identified for each objective. Within lessons, the media choices were altered so that all segments in a lesson were presented in a single medium. Four alternative media plans were developed. Each plan assumed that a different subset of the entire range of media would be available for Phase II development and implementation. The number of segments presented in each medium for each plan was then tallied, and the relative cost of developing and implementing the instruction for each media plan was determined.

LESSON SPECIFICATION DEVELOPMENT

The final phase of this project was development of lesson specifications. The lesson specification defines the critical content to be presented for each objective. It specifies information to be learned, examples to be presented, instructional "helps" to be given, practice problems, feedback, and instructions to be given, and the way in which these components are to be sequenced. Primary input to lesson specification was provided by Navy SME based on training, methodology, and review provided by the Contractor.

The general conclusion of this study was that the ISD model used was feasible and was sufficiently prescriptive to be used in a standardized fashion. A number of problems were encountered which suggested the necessity for revision of the basic model or the way it was implemented. Certain revisions were carried out within the project itself. These included the computerization of the media selection process, elaboration of the objectives hierarchy analysis algorithm, and simplification of the lesson specification procedure. Other recommendations were made for subsequent efforts. These included (1) strengthening the basic ISD model in the areas of problem analysis and the interface between media selection, sequencing, and training support requirements analysis, and (2) improving the ISD implementation procedures in the areas of job analysis survey, utilization of SME, and extended utilization of computers in several ISD tasks.

A second major result of the study was development of a set of ISD personnel requirements estimation data. For each of six major ISD tasks the number of hours required by personnel in three categories (instructional designer, instructional technologist, SME) was determined. These data can be used with varying degrees of confidence for predicting personnel requirements for other, equivalent ISD projects.

PREFACE

The Naval Training Equipment Center has a continuing interest in the evaluation of the methodology used in the design and development of training. Recent interest has centered on the systems approach to training, now referred to as instructional systems development (ISD). (Detailed descriptions of the methodology can be found in the Implementation section and in Appendix A). This EA6B project was one of four such projects (SH2F LAMPS, A6E TRAM, and E2C Weapon Systems) conducted by the Naval Training Equipment Center for the Naval Air Systems Command to design and develop a SH2F aircrew training system and to establish the requirements for implementation of the ISD process within Naval Air. The work was performed by Courseware, Inc. under Contract N61339-75-C-0100. A two-phase ISD effort was planned. Phase One was completed and is described in this report.

The operational objectives were to develop an aircrew training program using the ISD process, to evaluate the new training program, to design a training program that permits revision as weapon system hardware is modified, and to implement an ISD instructor training program.

The research and development objectives were to evaluate a variety of ISD approaches under several operational situations, and to acquire manpower/skill types, scheduling, and cost information for future ISD planning.

Special appreciation is expressed to LCDR R. Colyar, VAQ-129, who was responsible for arranging on-site facilities and subject-matter expert support and for his contributions toward definition of ICAP content. Other personnel involved in the project are named below, not in order of the magnitude of their contribution but simply in terms of their participation, cooperation and assistance in the successful completion of Phase One of the project.

<u>VAQ-129</u>

CDR L. P. Stone, CO
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INTRODUCTION

PROBLEM/BACKGROUND

PROBLEM SETTING. The EA-6B ISD project emerged from two converging needs, both of which shaped project planning and execution in significant ways. One of these was the very straightforward requirement for developing a training program for the Improved Capability (ICAP) version of the EA-6B "Prowler," which was scheduled for introduction to the Fleet in 1976. The other was a more general, fundamental need on the part of those significantly involved in Naval Air Training for information about Instructional Systems Development (ISD)--its methods, its costs, and its feasibility. The Naval Training Equipment Center (NAVTRAEQUIPCEN) represented these more fundamental concerns within the Naval air community. The EA-6B effort was one of four aircrew training projects conceived, organized, and directed by NAVTRAEQUIPCEN in an attempt to answer some serious questions about ISD.

On 24 April 1975 specific project work to develop the aircrew training program for the ICAP version of the EA-6B aircraft began at the Naval Air Station, Whidbey Island, Washington. The project was designed to employ ISD technology in the establishment of the training program. However, the project was limited to a Phase I effort, covering only the analysis and design steps of ISD. Development, implementation, and evaluation of the final instructional program was to occur during a second, Phase II project. The Contractor was to provide on-site ISD training and guidelines for Phase 1. The Navy's Tactical Electronic Squadron (TACELRON) Number 129 (VAQ-129) which is the Replacement Aircrew Training Squadron for all EA-6B aircraft, was to provide the technical subject-matter input to the training development and the on-site facilities. NAVTRAEQUIPCEN was to serve as project coordinator and monitor. A detailed account of the two major problems that shaped the present project appears below.

THE EA-6B (ICAP) TRAINING REQUIREMENT.

ICAP Implementation. The first EA-6B ICAP aircraft was scheduled for delivery to the Replacement Aircrew Training Squadron (VAQ-129) at the Naval Air Station, Whidbey Island, in May or June 1976, with two additional aircraft arriving the following month. From then on, aircraft were to be delivered to the Navy at the rate of approximately one every two months through fiscal year 1977. Training on the ICAP version was planned to commence in October 1976.

System Description.

The Aircraft. The EA-6B (ICAP) is a third generation tactical jamming Navy aircraft designed and built by Grumman Aerospace

Corporation. The aircraft is carrier suitable, long range, and all weather capable, making it ideally suited for operation anywhere in the world. Two internally mounted Pratt Whitney J-52 axial flow turbojet engines provide the EA-6B with a highspeed, high altitude capability necessary to support strike force aircraft. The tandem arrangement of the four-man crew maximizes the effectiveness, precision, and safety of the advanced avionics navigation and radar system.

The Mission. The primary mission of the EA-6B (ICAP) aircraft is to support strike aircraft and ground troops by suppressing enemy's electronic activity. The aircraft has an integrated Electronic Countermeasures (ECM) system consisting of the receivers and an on-board system to monitor electronic activity, and up to five externally-carried jammer pods. The improved capability EA-6B aircraft, or ICAP, utilizes "state-of-the-art" electronic receiver and transmitters. The newly designed display system provides the operator with an instantaneous visual presentation of the entire electromagnetic spectrum in the area of operation. The side-by-side seating of the electronic countermeasures operators (ECMOs) and advanced cockpit design greatly improves crew efficiency and system effectiveness.

The Crew. The EA-6B (ICAP) is a four-position aircraft. Each of the four crew members has explicitly defined job tasks which are conducted in close coordination with the other three crew members. The forward cockpit holds the Pilot and the Navigator. Two ECMO occupy the aft cockpit. The Pilot's responsibilities encompass all aspects of aircraft flight. The Navigator, who is a Naval Flight Officer (NFO), performs navigation duties using radar and other navigation-related avionic systems. He also is responsible for communications tasks and for assisting the pilot in performing checklists and certain other flight-related activities. There is no ECM gear in the forward cockpit. The two ECMO in the aft cockpit are both NFO. Their primary responsibility is the management, implementation, and tactical operation of the aircraft's ECM systems. Seated side-by-side, they share both the ECM operations load and certain common control panels.

The Training Program. Since the EA-6B (ICAP) aircraft is not yet fleet operational, there is no ongoing training program for that aircraft. However, the two forerunners to the ICAP version (the EA-6B standard version, and EXCAP version) are currently in fleet use, and ongoing aircrew training is being conducted. The VAQ-129 training program for these two aircraft is approximately 26 weeks long. The schedule for classes for 1975, 76, and 77 is shown in Figure 1. A summary of the course outline is shown in Table 1.

The ongoing course of instruction offered by VAQ-129 is geared toward training the student who is inexperienced with the EA-6B. Refresher students are given a subset of the full training course. Classes commence six times a year, at approximately

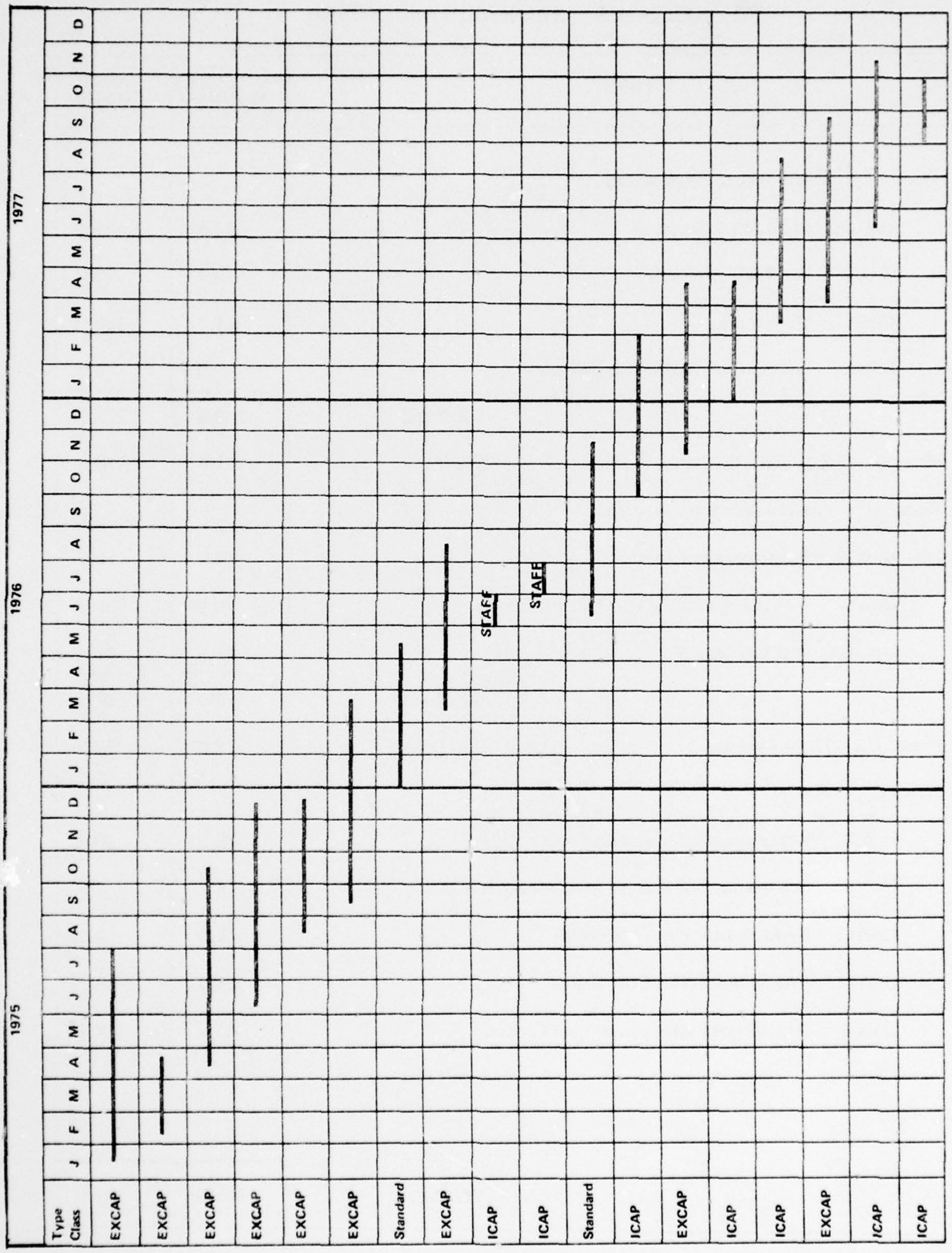

Figure 1. EA-6B Training Schedule

TABLE 1. OUTLINE OF THE PRESENT EA-6B TRAINING SYLLABUS (STANDARD AND XCAP)

TOPIC		STANDARD HOURS	EXCAP HOURS
Phase I. Flight Support Instruction			
Unit A. Pre-flight instruction		91.5	91.5
Unit B. Pre-flight self-study		13.0	12.5
Unit C. Systems		130.0	140.0
Unit D. Carrier Qualification Procedures		9.0	9.0
	Sub Total	243.5	253.0
Phase II. Electronic Warfare and Tactics	Sub Total	152.0	160.0
Phase III. General Aviation Instruction			
Unit A. Familiarization trainer		14.5	8.5
Unit B. Part task trainer (EXCAP Version only)		0.0	30.0
Unit C. Part task trainer		11.5	44.0
	Sub Total	26.0	82.5
Phase IV. Flight Planning	Sub Total	77.0	53.0
Phase V. Flights			
Unit A. Replacement pilot familiarization flights		25.0	16.5
Unit B. Replacement pilot crew familiarization flights		4.5	4.5
Unit C. Replacement pilot ESM flights		6.0	6.0
Unit D. Replacement pilot ECM flights		30.0	30.0
Unit E. Replacement pilot carrier qualification		19.4	19.4
	Sub Total	84.9	76.4
	TOTAL	582.4	624.9

eight-week intervals, and run consecutively for 26 weeks. Normally, the classes have 20 students--six pilots and 14 NFO.

It is important to point out that while this course outline is fairly stable, the actual instruction within many of the units is highly subject to change. Present VAQ-129 instructors estimate that the entire syllabus goes through major revision once every eight months. This means that approximately 20 percent of the instruction is changed for each class.

While the entry level of each student varies, minimum acceptance levels have been clearly established. To date, pilot students must have satisfactorily completed one full cruise in another carrier-type aircraft, usually a fleet-type jet. However, there is discussion indicating that the cruise requirements for pilots will be dropped when ICAP training begins. Thus, some of the pilots will come into the training program directly from flight training where they have just received their pilot wings. NFO are required to be graduates of the Navy's Electronic Warefare Academy in Pensacola.

Prior to their actual arrival at VAQ-129, these students attend three preparatory courses. These are:

- Survival, Escape, Resistance and Evasion (SERE) School
- Flight Instrument Refresher Course
- Deep Water Survival Training (DWST)

Part of the training course also serves as a refresher course for pilots and NFO who are already EA-6B experienced. During normal rotation, these personnel are assigned to operational EA-6B squadrons for a normal sea duty tour, usually followed by shore duty in a related area. Before they can begin a second sea tour in an EA-6B squadron, they must complete the VAQ-129 refresher course.

The objective for both the initial and the refresher training courses is to train students to the point where they are fully NATOPS and carrier qualified prior to graduation. A pilot or NFO is NATOPS/carrier qualified if he can successfully conduct a complete carrier-based or shore-based ECM or ESM mission handling any emergencies which might occur. A detailed account of the NATOPS qualification requirements is contained in the EA-6B NATOPS manual. In order to determine whether or not a person meets the qualification standards, he is given a written open- and closed-book test, an oral examination administered by NATOPS evaluators and, finally, a performance evaluation in the aircraft.

After VAQ-129 training, students receive no other formal training prior to their assignment to operational EA-6B squadrons. Once in the squadron, pilots and NFO participate in squadron operations and air wing build-up exercises in preparation for carrier deployment. The length of these build-ups varies in specific instances from three weeks to three months. While on cruise, all personnel participate in refresher training sessions subject to squadron operating schedules.

THE ISD PROBLEM. At the time the EA-6B ISD project was being conceived, a number of serious questions about ISD were in the minds of those concerned with Naval Air Training.

At the most general level, the problem was whether or not the Navy should continue to go with ISD as the required approach to training. The ISD concept had been around for some time. All of the uniformed services, as well as many large educational and business organizations, had regulations which said that ISD was the preferred or required approach to instructional design and development. The general feeling was that ISD provided a framework that should lead to the development of instructional programs that are effective and efficient in developing job skills. In spite of this, it was very hard to present convincing evidence that ISD is workable, effective, or efficient in terms of resource consumption. There were two reasons for this lack of certainty.

First, almost all versions of ISD were seriously lacking in detailed, prescriptive guidance for conducting the various analysis and design phases which ISD requires. This was particularly true in the areas of content analysis (deriving sets of related objectives), method/media selection, sequencing, instructional strategy determination, lesson specification, and quality control planning. In other words, ISD approaches tended to describe broad steps or phases, but did not incorporate the detailed models, algorithms, and techniques from instructional science and technology which would make the approach really work in a standardized way in a typical training environment. Where ISD had been applied by instructional scientists, some subset of these required techniques had usually been employed, but this often occurred in isolation; techniques and results were generally not documented, and therefore these cases did not lead to any total ISD model being made usable in standard fashion by a normally staffed training establishment. Under such conditions, it was impossible to establish a track record for ISD because full scope ISD had never been consistently attempted.

Second, many ISD applications did not make adequate provisions for necessary resources: personnel, time, facilities, or money. Frequently, instructional developers were enjoined to apply ISD to their projects, but were not given proper training, or the right types and sufficient numbers of people, yet were constrained to produce finished courses within such tight

deadlines that even minimal analytic effort was virtually out of the question.

Given these two limiting factors, it is no wonder that some casual observers were ready to conclude that ISD was a good idea that didn't work. The more thoughtful approach, however, was to undertake a systematic study of an ISD project which was relatively free of the limitations described above. It was within this very broad context that the basic problem was perceived.

Given that the Navy was entitled to a thoroughgoing, representative study of ISD, a second level problem emerged: could a prescriptive, standard ISD model be developed and documented? The terms "prescriptive" and "standard" are critical parts of this problem statement. No ISD model can be accepted as successful if it does not meet both criteria. A prescriptive ISD model is one which provides the full range of procedures, algorithms, and techniques discussed previously rather than just a very general five or six step framework which doesn't show the developer <u>how</u> instruction should be developed. If an ISD model is prescriptive, then it can be used in a standard way across different training establishments within an organization. If ISD was to survive in the Navy, or anywhere else, evidence that ISD could meet these criteria had to be presented.

The third level problem was to determine whether a relatively unconstrained, standard, full-scope ISD model actually worked in terms of feasibility of application and ability to produce good, cost effective instruction. This was essentially an empirical question. What was required was the generation of ISD performance data within the context of a real instructional design project. The EA-6B (ICAP) was judged to be such a context.

Some of the specific feasibility questions that needed to be answered were: what kinds of people does ISD require and how much of their time is required to produce task listings, objectives hierarchies, media selections and specifications, course organization and sequencing decisions, and lesson specifications; how much does all of this cost; what problems arise in necessary interactions with Fleet communities during instructional design; what is an efficient phasing model for instructional design; what are the interrelationships between perceived needs for training equipment, their relative costs and effectiveness?

To recapitulate, the basic question concerned the desirability of applying ISD routinely to all programs within Naval Air Training. To answer the question it became necessary to apply a robust, full-scope ISD model, with adequate resource support, to a realistic air training problem and to measure the resulting effectiveness, cost and feasibility of the application.

The EA-6B (ICAP) was one of four programs selected for an ISD effort in this attempt to establish the vital statistics on ISD.

PROJECT GOALS

GENERAL. Since the project involved both research and applied training development thrusts, it was judged prudent at the outset to delineate project goals in some detail to ensure that there would be no working at cross-purposes. In general, research interests were perceived as directed toward the acquisition of data reflecting on the ISD process--its methodology, its effectiveness, its efficiency, and its resource demands. On the other hand, applied training development interests were perceived as focusing on the timely production of a high quality training program for the EA-6B (ICAP). At this level of generality there was no immediately apparent conflict between these interests.

APPLIED TRAINING DEVELOPMENT GOALS. Viewed from the standpoint of the Replacement Aircrew Training Squadron, the project needed to develop a training program which satisfied the following objectives:

- Provide standard aircrew training that is uniform in content with the minimum performance levels clearly stated, thereby creating completely objective-based gradeing criteria.
- Provide an effective and efficient training program within the time schedule established by higher authority which maximizes the use of existing or contracted for training devices, assigned instructor assets and available classroom space, and considers the students' abilities and entry level skills.
- Provide a viable, ongoing revision program that responds in a timely manner to fleet or student needs. Cost, effectiveness, and turn-around time must be the prime considerations of the updating program.
- Provide an instructional program that could be used in EXCAP or Standard Version training where it is common to ICAP Training.
- Provide suitable instructor orientation and training to ensure effective and efficient implementation of the training effort.
- Make provisions for student control, scheduling, monitoring, testing, and tracking. Implied in this objective is the requirement to provide testing that is objective-based, criterion-referenced, and is diagnostic in nature.

These goals were exclusively related to the training products and materials to be developed on the project. However, it was clear that total accomplishment of these goals could not be realized as a result of the Phase I effort because of its inherent limitations in scope. Clearly, a useable training program would have to await completion of a later, Phase II effort.

RESEARCH-ORIENTED GOALS. There were four specific goals identified with the research orientation of the project. They were:

- To develop a full-scope ISD methodology which specifies techniques and procedures which can be used in each step of the instructional development procedure.

- To validate the utility of these techniques.

- To determine the personnel, time, and cost requirements to conduct an ISD effort.

- To collect a set of data to support or refute the desirability of routinely employing ISD.

These goals clearly mapped on to the questions and concerns about ISD described earlier in this report. The fact that the EA-6B (ICAP) was just one of four similar projects enhanced the probability that useful, representative data would be forthcoming. However, as in the case of applied training development goals, potential accomplishment was limited by the restricted scope of the Phase I effort. It was apparent that collecting data on the full range of ISD activities and validating the utility of ISD methodology would have to await completion of Phase II.

DISCUSSION. There appeared to be no inherently serious conflicts between the project goals related to research and those related to applied training development. Only two potential problem areas were identified. The first was a possible conflict over research orientation versus applied training development orientation in the event that personnel or resources were committed to one to the detriment of the other. The second problem concerned the Contractor's potential inability to fulfill research requirements or systematic training development requirements in the event that the pressing need for a useable training program by October, 1976, caused the Replacement Aircrew Training Squadron to divert its scheduled project support resources to other activities it might judge more beneficial.

ASSETS AND CONSTRAINTS

GENERAL. The training assets and program constraints bearing on the project at the time it began are described below. Assets represent resources within the existing EA-6B training system that were potentially applicable to the ICAP program being designed; during development or implementation or long-term evaluation and maintenance. Constraints represent firm outer limits on resources available to the program. Both assets and constraints can be discussed in terms of people, time, facilities, equipment, and money.

INSTRUCTIONAL HARDWARE ASSETS. In order to successfully accomplish the previously outlined training, VAQ-129 made use of a wide array of instructionally related hardware devices. A listing of these devices and usage data is presented in Table 2.

In addition to the resources shown in Table 2, a new Part-Task Trainer (15E22A) and a Weapon System Trainer (2F119) was scheduled to be purchased for ICAP training. The 15E22A was to contain two rear cockpit ECM operator seats. The 2F119 was to have one full set of aircraft positions (i.e., four seats) mounted on a motion platform. Both devices were to be designed to accurately simulate every aspect of normal and abnormal EA-6B operation. In addition to the simulation capability, the 2F119 has a limited built-in pilot performance evaluation capability. It can be programmed to keep track of the frequency and extent to which the student exceeds pre-set flight maneuvering tolerances. For example, it can produce a listing of how often the student overstresses the aircraft, or how often he descends at more or less than a given acceptable rate. Up to six parameters can be measured at once for the pilot position. The 15E22A was scheduled for delivery on May 15, 1976. The contract to build the 2F119 had not yet been awarded. Therefore, the December, 1977 delivery date was very tentative.

INSTRUCTIONAL MATERIALS PRODUCTION CAPABILITIES. The following media production capabilities were available to VAQ-129 to support the training program. Overhead transparencies and limited artwork could be produced within the training department by the assigned draftsmen. Thirty-five millimeter slides could be shot by the station photo lab if they were provided camera-ready originals. Production of sound-on-slide presentations was usually handled within the training department. All printing of instructional materials was handled by Naval Publications and Printing Service office at Bremerton, Washington. In the area of videotape capability, VAQ-129 was limited to black and white production only, in studio as well as portable equipment. Color capability, however, appeared to be reasonably available within the Navy system. Motion picture capability was minimal at best.

TABLE 2. INVENTORY AND USE OF VAQ-129 TRAINING HARDWARE

Instructional Device	Number of Devices Available	Hours Per Day Present In Use	Hours Per Day Available For Use	Personnel Requirements
Sound-on-slide projector	6 Players 3 Recorders	2 hrs.	24 hrs.	0 hrs.
Carousel slide projector	4	2 hrs.	24 hrs.	Use as an instructor aid.
Overhead projector	3	4 hrs.	24 hrs.	Use as an instructor aid.
Opaque projector	1	0 hrs.	24 hrs.	Use as an instructor aid.
Reel-to-reel tape recorders	3	0 hrs.	24 hrs.	Use as an instructor aid.
16 mm movie projector	3	1/2 hr.	24 hrs.	Use as an instructor aid.
Videotape units: Camera	4			
Reel-to-reel recorder/player	3			
Cassette recorder	2	2 hrs.	24 hrs.	Use as an instructor aid.
Cassette player	2			
Monitors	5			
15E22 Trainer	1	16 hrs.	16 hrs.	1 instructor per student.
A6A Trainer	2	16 hrs.	16 hrs.	1 instructor/student, 12 maintenance people.
15E34 Trainer	1			
EA-6B Aircraft	9	16 hrs.	16 hrs.	24 maintenance people/aircraft

INSTRUCTIONAL FACILITIES. The VAQ-129 training department was housed in Building 243. They had for their use three classrooms and two self-study areas in which to conduct the classroom portion of the training program. Two of the classrooms comfortably held 12 students each, while the third held 15 students. The Electronic Warfare Library contained a six-carrel self-study area for viewing of videotapes and sound-on-slide presentations. Additionally, there was a large planning room that students utilized for individual or group study.

An additional building was scheduled for construction to house the 15E22A and 2F119 trainers. This building was also to have one small classroom.

PERSONNEL ASSETS. At the time the project began, the aircrew training department of VAQ-129 was assigned 29 instructors, 15 of whom were directly involved in classroom instruction. Two instructors presented the familiarization and navigation sections of the syllabus; three presented the electronic warfare sections; three presented the aircraft systems section; five were assigned to the 15E22A part-task trainer. All assigned instructors also instructed in the flight portion of the student's syllabus. Additionally, 16 other designated flight instructors were provided by the squadron, whose major duty assignment was not within the training department. Instructor resources were expected to remain the same for ICAP training.

INSTRUCTOR TRAINING. New instructors assigned to VAQ-129 from operational EA-6B squadrons were prepared to be instructors by completing the Instructor Under Training (IUT) syllabus. A brief summary of the IUT course outline is presented in Table 3.

CONSTRAINTS. The chief constraints that were apparent at project onset were:

- Navy subject-matters experts would be limited to two full-time personnel.
- No major training devices, beyond those described above, would be available for ICAP training.
- Project progress must proceed at a rate which would permit complete development of the ICAP training program by October 1976.

TABLE 3. IUT SYLLABUS

TOPIC	TIME
1. Introduction	3.0 hrs.
2. FAM/NAV phase	
a. NAMO	8.0 hrs.
b. Emergency procedures	3.5 hrs.
c. Local course rules	2.0 hrs.
d. Aircraft pre-flight and servicing	2.0 hrs.
e. Navigation Systems Review	1.5 hrs.
f. General flight-conduct	1.0 hrs.
g. PF/NF stage-conduct and techniques	1.0 hrs.
h. PFT/NFT	1.0 hrs.
i. Trainers on scene review	1.0 hrs.
j. Standardization flight	2.0 hrs.
k. A-6A WST	2.0 hrs.
3. Systems Phase	
a. OBS review	4.0 hrs.
b. POD review	4.0 hrs.
c. Systems Exam	4.0 hrs.
d. 15E22 Trainer	4.0 hrs.
4. Mission Planning Phase	2.0 hrs.
TOTAL	46.0 hrs.

SECTION II

INSTRUCTIONAL SYSTEMS DEVELOPMENT

BACKGROUND

At the time the EA-6B project began in mid-1975, ISD had close to a ten year history in the field of training technology. This field had been undergoing its own rapid expansion during the ten previous years, with a mixed record of successes and failures. During these years, education and training were under considerable pressure to develop more effective methodologies. With the 1950's came an increasing awareness that traditional methods were lagging behind real world requirements for teaching expanding bodies of knowledge to an expanding student body. On the civilian scene the use of the popular catch phrases "population explosion" and "knowledge explosion" symbolized these requirements in a fairly accurate way. There developed a widespread perception of the educational system as inadequate. This was heightened further in later years when science studies were lionized during the early days of the space age and when the "Why Johnny Can't Read" controversy focused public attention on even more basic problems. On the military scene, the early 50's and 60's both witnessed rapid build-ups in personnel strength, with inevitable pressures on training methods and capabilities.

It is important to understand that all of this was taking place in the context of a generally expanding technology. Responding to the pressures for change, the world of education and training seized what it could find and used it, sometimes with disastrous results. Although such "outside" technologies as audiovisual, television, computers, and systems engineering eventually became fair game, the first and ultimately most significant technology to be harnessed in education and training was a more or less homegrown product: instructional objectives and programmed instruction (PI). Two of the most fundamental procedures in ISD came from these theory-based concepts. One was the idea of objectives or explicit behavioral outcomes of learning as the cornerstone of instructional design and development. The other was the idea of program evaluation and revision based on empirical tryout. These notions have survived relatively intact over twenty years or more.

What did not survive in nearly so robust a form was the attempt to cram virtually every kind of teaching into the "frame" format associated with programmed texts. Despite admonitions by its more systematic proponents that PI was really a <u>process</u> more than a <u>product</u>, the product orientation won out. Vast quantities of programmed materials were generated quite unsystematically. Much of this material turned out to be trivial or ineffective. Unfortunately, the great proliferation of teaching machines which came in the wake of the PI boom resulted only in a more efficient delivery of untested,

inconsistent instruction of doubtful quality. Predictably, the bubble burst and PI was widely condemned--mostly for the wrong reasons.

This same pattern has repeated itself again and again with various technologies. "A/V" (audiovisual), "SRS" (student response system), "ETV" (educational television), "CAI" (computer-assisted instruction) and others have taken turns in the forefront of education and training technology. Each has been regarded as the final solution to the serious problems in the field. Each has crashed as a result of uncritical and unsystematic application.

It finally came apparent that, despite the existence of the cornerstone concepts--objectives and quality control--and despite the rich array of devices available, most instructional programs were being developed using as many theories of instruction as there were developers. In many cases objectives were added to instruction as an afterthought, rather than driving lesson development as they were intended. In only a few cases were the prescribed empirical tryout and revision steps being carried out consistently, particularly in large scale training projects. As a result, most instructional programs could be characterized as having one or more of these problems:

- Critical content is left out.
- There is an overabundance of content which represents what the instructors like to talk about, but which may be irrelevant to program needs.
- There is no clear definition of what is supposed to be learned.
- Instructional methods and media are selected either by default, or by the hardware specifications that appear in promotional literature.
- Testing is oriented to general content familiarity rather than to achievement of specified learning outcomes.
- There is a general lack of correspondence among the instructional program goals, the instructional materials, and the tests.
- Instructional design and development efforts tend to be inefficient in terms of the kinds of personnel used and the roles in which they are used (e.g., instructional content experts are used as instructional process experts).

- Little or no attention is given to assessing the effectiveness of the instructional program, or to providing a means for keeping it current.

ISD evolved in response to these symptoms and their underlying causes. It represented an attempt to systematize the procedures used in instructional design, development, and evaluation; to make the procedures explicit and orderly, and to provide some guidelines for carrying them out.

Systems engineering and human factors concepts made significant contributions. The development process was broken out into a series of manageable components which could be defined and related to other components in terms of inputs, outputs, and feedback. Procedures relating to front-end analysis of problems and tasks were introduced, thereby strengthening the relationship between instruction and real world performance and learning requirements.

By the late 60s the ISD concept was well-known, although under a variety of terms such as "The Systems Approach," "Systems Approach to Training (SAT)" and "Systems Engineering of Training." It was in widespread use within government and industry. It purported to define a set of procedures for producing effective, efficient, relevant training programs; programs in which the objectives, the materials, and the tests were consistent with each other, and with post-training performance requirements.

It was claimed that cost savings accrued to ISD because the "lean" (need to know) courses resulting from ISD were developed more efficiently and could be significantly cut back in length as compared to their more conventionally designed versions.

Yet at the end of ten years experience with ISD, serious questions could be raised about it. These concerns have been detailed in the Introduction to this report. Briefly there are two main problems. The first problem is reminiscent of those experienced in the 50s and 60s. The fact is that most ISD models are solid on the ends (front-end analysis and quality control) but soft in the middle (design, development, and implementation). Only very general guidance is provided in such areas as objectives development, selection of media, specification of instructional strategies, and others. The result is that much of the detailed work in course development is still intuitive and artistic and very much dependent on the developer's theory of instruction. What this means is that ISD has not yet achieved the level of a standard technology. This is why it is difficult to make general statements about the applicability or projected results of ISD with very much confidence.

The second problem concerns the logistical or resource support provided for large-scale ISD projects. Typically, ISD

has not been provided with the time or personnel resources necessary to implement a sophisticated system. The result is that many ISD applications have been seriously hampered, to the point where "system" had to give way to "make do." In a very real sense ISD has not had a full-scale tryout for this reason. One main reason for poor resource support is a lack of information about what ISD costs. This was one of the questions that the EA-6B ISD project was designed to solve.

ASSUMPTIONS

The following assumptions underlie the particular ISD model used for this project:

- Human performance problems are frequently best solved by management action or situational modifications. Training programs should be established only when these more direct solutions are unavailable.

- The content of an instructional program must be relevant to the performance requirements of the job, position or duty for which the course is preparing the students. The course should teach what is required on the job.

- A good instructional program must be efficient in terms of accomplishing its goals with minimum consumption of instructional resources (time, money, people, facilities).

- The most effective instructional programs are those which are predicated on some form of explicit learning outcomes or objectives.

- The selection of any instructional method, medium, or device should be based on the kind of learning situation involved. The "goodness" of such methods cannot be spoken of in the abstract, but in terms of some specific learning situation, or class of learning situations.

- All instructional programs are something less than fully effective and fully efficient due to mistakes made by instructional designers, particularly during the early versions of the course. A good instructional design system must, therefore, provide for empirical testing of the instruction, followed by revision or modification in those areas of instruction that have been shown to be ineffective or irrelevant.

o All ISD models have both process and content inputs. The most accurate and relevant content input source is the client who will be using the final product of the development process. The most competent process input sources are individuals who have had extensive training and experience in instructional science and technology.

METHODOLOGY

The ISD methodology employed by the Contractor in this project did provide the type of prescriptive guidelines necessary to support a standardized ISD model. It used the basic framework of the Army's "Systems Engineering" model (AR 350-100-1, 1968), supplemented by detailed algorithms that were designed and tested during almost two years of ISD experience with the Navy's S-3A aircrew training development project. An overview of the ISD methodology that was employed may be found in the document entitled, "A Systems Approach," which is Appendix A of this report. A very detailed account of the methodology will be found in the Implementation section of the report and in Appendix B. A brief summary appears below.

The general framework of the ISD model was a seven-step procedure, as shown in Figure 2.

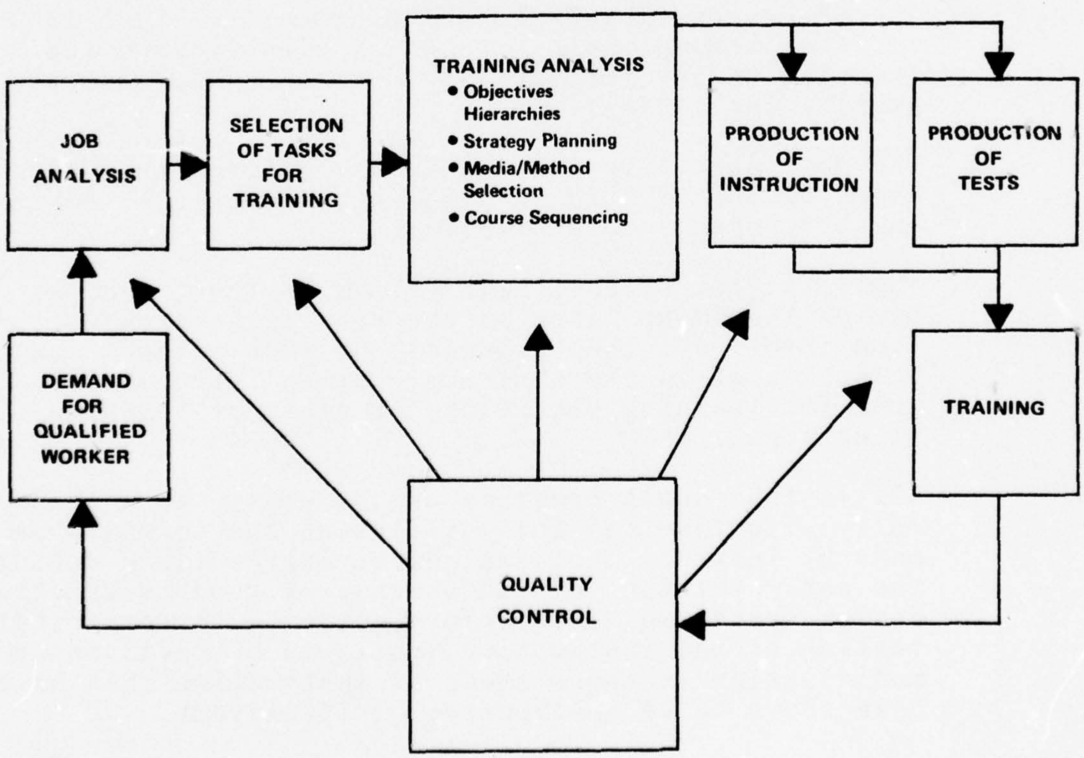

Figure 2. The General Framework of the ISD Model Used in the EA-6B (ICAP) Training Development Project

The first step in this ISD model is to perform a Job Analysis. This analysis outlines the goals and objectives that the final training program must meet. It also lists in detail those resources and constraints that exist in the present training environment, and those that will be in effect in the program being developed. Finally, it presents a complete listing of every task a qualified job holder must be able to perform.

The task listing forms the basis of the next step in ISD: the Job Analysis Survey. In the Job Analysis Survey, qualified job holders are questioned regarding where they learned, where they first performed, and how often they perform each of the tasks outlined in the task listing. The results of the Job Analysis Survey are used to determine which tasks will be trained in the course being developed.

Once the tasks have been selected for training, they are analyzed in greater detail through the development of objectives hierarchies. These hierarchies show all the component objectives for a major task, arranged from the simplest and most fundamental up to the most complicated and advanced. Behavioral objectives are used to specify the decisions a student must make, or actions he must be able to perform to successfully carry out each task. They also specify the conditions under which the tasks must be performed, and the minimum acceptable performance standard. These objectives are laid out in hierarchies to make clear the relationships existing between them.

Once the objectives have been developed, they are sequenced and grouped into units and lessons. This sequencing is determined on the basis of three rules. First, objectives must be sequenced such that objectives which are lower in a hierarchy (more basic learning) are taught prior to higher level objectives in the same hierarchy (more advanced learning). Second, the sequencing should allow for early hands-on experience with real tasks wherever possible. Finally, when sequencing independent "legs" of a hierarchy, the most critical or difficult leg should be presented first in order to provide the largest possible amount of practice time for difficult material.

Closely tied to course sequencing is media selection. The optimal presentation media for each objective are determined on the basis of the behavior involved (e.g., will the student be memorizing information or using it to solve problems?), the content involved, and the minimum instructional display and response detection requirements (e.g., will the instruction require words only, or pictures, or color or movement, or real objects?). These decisions are based initially on learning requirements only, but are then modified to conform to resources available, and to consolidate media within a lesson.

After media decisions have been made, production of Lesson Specifications begins. A Lesson Specification outlines the instructional strategy and the critical content for each objective. It specifies the number and types of examples, practice items, and test items.

The next step of the development process is the actual authoring of lesson and test material. To prepare this material, authors are given the Lesson Specification for a set of objectives. They are also given a lesson guide that explains how to produce instructional material for each of the media which are being used. The authors, who are qualified subject-matter experts, then produce a rough draft of the lesson. This draft is reviewed by an instructional design specialist and an independent subject-matter expert. It is then revised and produced in smooth form.

The final step in the development process is to conduct a tryout and formative evaluation of the material. Based on the data collected in the tryout phase, the material is revised and evaluated again. Where necessary, the objectives and hierarchy are revised to more accurately reflect the structure of the task being trained.

The scope of the EA-6B (ICAP) development project was only concerned with development up to, and including production of lesson specifications.

A summary of these major ISD steps in terms of their inputs, outputs, and basic processes is shown in Table 4.

TABLE 4. INPUTS, OUTPUTS, AND PROCESSES INVOLVED IN THE MAJOR STEPS IN ISD

ISD STEP	PROCESS	INPUT	OUTPUT
1. JOB ANALYSIS	Analysis of training requirements, & project goals, assets & constraints.	Descriptive statements from qualified subject-matter experts & training program managers; training documents; observation of the training environment.	Job Analysis Document o Project goals o Assets & constraints o Task listings
TASK LISTING	Analysis of personnel functions & responsibilities to determine the major tasks performed.	Descriptive statements from qualified subject-matter experts.	Task Listing A list of major tasks performed within each area of responsibility, mission, & mission phase.
GOALS ANALYSIS	Analysis of the goals & objectives of the major participants in an ISD project.	Descriptive statements from qualified representatives of the participating organizations; pertinent documents.	A listing of project goals by participating organizations.
ASSETS & CONSTRAINTS ANALYSIS	Analysis of the projected training environment to determine the availability of training-related resources & training-related constraints.	Descriptive statements from training managers; pertinent documents; observation of the training environment.	An inventory of personnel, equipment, & facility assets by type & number; a listing of pertinent constraints & limitations.
JOB ANALYSIS SURVEY	Validating the task listing & securing additional data about each task for use in the next step.	Questionnaire entries by experienced job holders; their responses to questions about each task on the task list.	Supplementary information to the task list: frequency & criticality of task performance; when learned; when first performed.
2. SELECTION OF TASKS FOR TRAINING	Analysis of all tasks on the list to determine which must be trained for in the program.	Results of Job Analysis Survey; information about student's entry level from training managers.	Categorized task listing in which each task is identified: for training, not for training, for subsequent training, for familiarization or review only.

TABLE 4. INPUTS, OUTPUTS, AND PROCESSES INVOLVED IN THE MAJOR STEPS IN ISD (CONT)

ISD STEP	PROCESS	INPUT	OUTPUT
3. TRAINING ANALYSIS	Analysis of tasks to determine objectives. Analysis of objectives to determine media. Establishment of a sequenced syllabus with instructional strategy specifications for each lesson.	Categorized task listing from Step 2; content data from qualified subject-matter experts; assets & constraints data from Job Analysis Document. Also algorithms & formats for media selection, sequencing, objectives analysis & classification, & lesson specification.	Sequenced syllabus (course organization) with media identified for each lesson; an instructional strategy specification for each lesson; a list of required training equipment & devices.
OBJECTIVES ANALYSIS	Analysis of tasks to determine the hierarchical structure of component skill & knowledge objectives; classification of each objective into type of learning required.	Categorized Task Listing from Step 2; objectives analysis algorithm; content data from qualified subject-matter experts; objectives classification model.	Hierarchy of supporting objectives for each major task selected for training, including a designation of the type of learning required by each objective.
COURSE ORGANIZATION & SEQUENCING	Organizing objectives into meaningful, practical instructional units; sequencing the units to facilitate teaching & learning.	Objectives hierarchies; organization & sequencing model; class size & student throughput data from job analysis document; data from training manager.	Structured & sequenced course objectives graphically illustrated in a set of unit & lesson "maps".
MEDIA SELECTION	Analyzing objectives to determine the instructional methods & media that would be most effective to teach each one.	Hierarchies of classified objectives (output of Objectives Analysis); media selection algorithm; unit & lesson maps.	Alternative media choices for each chunk of instruction shown on the lesson maps.
LESSON SPECIFICATION	Determining the type & sequence of instructional components to be used for each chunk of instruction (instruction strategy design).	Lesson maps with media selected; instructional strategy expertise; lesson specification model.	A blueprint or prescription for developing each chunk of instruction, including critical content components, & proposed arrangement of examples, practice, feedback, & other vital components.

TABLE 4. INPUTS, OUTPUTS, AND PROCESSES INVOLVED IN THE MAJOR STEPS IN ISD (CONT)

ISD STEP	PROCESS	INPUT	OUTPUT
4. PRODUCTION OF INSTRUCTION	Developing usable instructional materials by providing the content inputs called for in the lesson specification.	Lesson specifications & maps (output of previous two steps); content data from qualified subject-matter experts.	Fully developed, ready to use instructional materials.
5. PRODUCTION OF TESTS	Developing tests by providing the content inputs called for in the lesson specification.	Lesson specifications & maps (output of previous two steps); content data from qualified subject-matter experts.	A complete set of knowledge & performance tests, ready to use with the instructional materials.
6. TRAINING	Conducting actual training of real students according to the predetermined training schedule, using newly developed materials.	Instructional materials & tests developed in Steps 4 and 5.	Individuals trained to the levels specified in program goals; data for use in quality control activities.
7. QUALITY CONTROL	Planning for and implementing ongoing course revisions & updates based on a variety of data which reflect on the effectiveness & efficiency of the instructional program.	Test data, student attitude data, instructor & training manager observation, post-training surveys of course graduates & their supervisors.	Revisions of the instructional materials & of the training system which result in more effective, more efficient, more palatable, more technically accurate training.

One required ISD step was missing from this model at the outset of the project. It had been previously recognized that adequate logistical support in ISD required interaction between the ISD process and the logistical support system. In particular, it became apparent that this logistical system had to have input to the media selection process in order to avoid specifying media requirements in excess of available resources. It also was apparent that once acceptable media selections were made, this information had to be fed to the logistical support system in order to allow sufficient planning and procurement time.

This interaction step was planned into the EA-6B project. This meant that part of the Contractor's project work would involve developing and testing a systematic procedure for carrying out this vital step.

SECTION III

IMPLEMENTATION

OVERALL PROJECT ORGANIZATION, STAFFING AND PHASING

ORGANIZATION AND PERSONNEL. As indicated earlier in this report, the roles of the three participating organizations were:

- Contractor - On-site training, guidelines, and review with respect to ISD processes and techniques.
- VAQ-129 - Subject-matter input and provision of on-site facilities for project personnel.
- NAVTRAEQUIPCEN - Project coordination, direction, and monitoring.

These responsibilities were not carried out within the framework of any formal, project-level organizational structure. The activities of Navy personnel were governed by the existing VAQ-129 command structure. The role of the Contractor was that of technical advisor rather than project executive. The Contractor and NAVTRAEQUIPCEN engaged in considerable technical liaison through monthly reports, quarterly briefings, and document submission and review.

Additional information about project organization is available in the list of titles and functions of project-related personnel, by organization, which appears in Table 5. The list covers the lifetime of the Phase I project.

TABLE 5. TITLES AND FUNCTIONS OF PROJECT PERSONNEL

ORGANIZATION	TITLE AND FUNCTIONS
NAVTRAEQUIPCEN	Scientific Officer and EA-6B SAT Project Monitor - Overall project coordination; interface between EA-6B and other SAT projects; technical monitoring of the project.
VAQ-129	Commanding Officer, Executive Officer, Director of Training, and Training Officer - Authorization and allocation of Squadron facilities and personnel (SME). Special Projects Officer - Coordination of day-to-day activities; interface between Squadron, Contractor, and technical monitor. Subject-matter Experts - EA-6B content input to task listing, objectives hierarchy development, course sequencing, lesson specification.
CONTRACTOR	On-site Project Director and Instructional Technologist - Specification of basic ISD methodology; SME training; materials review; primary input to selection of tasks for training, media selection, course organization and sequencing, and training support requirements analysis; maintenance of research data. On-site SME - EA-6B pilot content input - all phases. Technical Monitor - Quality control and review of instruction-related processes and products. Management Monitor - Quality control and review of management-related project activities, milestones, and deliverables. Consulting and Training Support Group - Consultation on research efforts; materials development and on-site support for SME training; consultation on ISD methodology.

The project organization of the Contractor's personnel is shown in Figure 3.

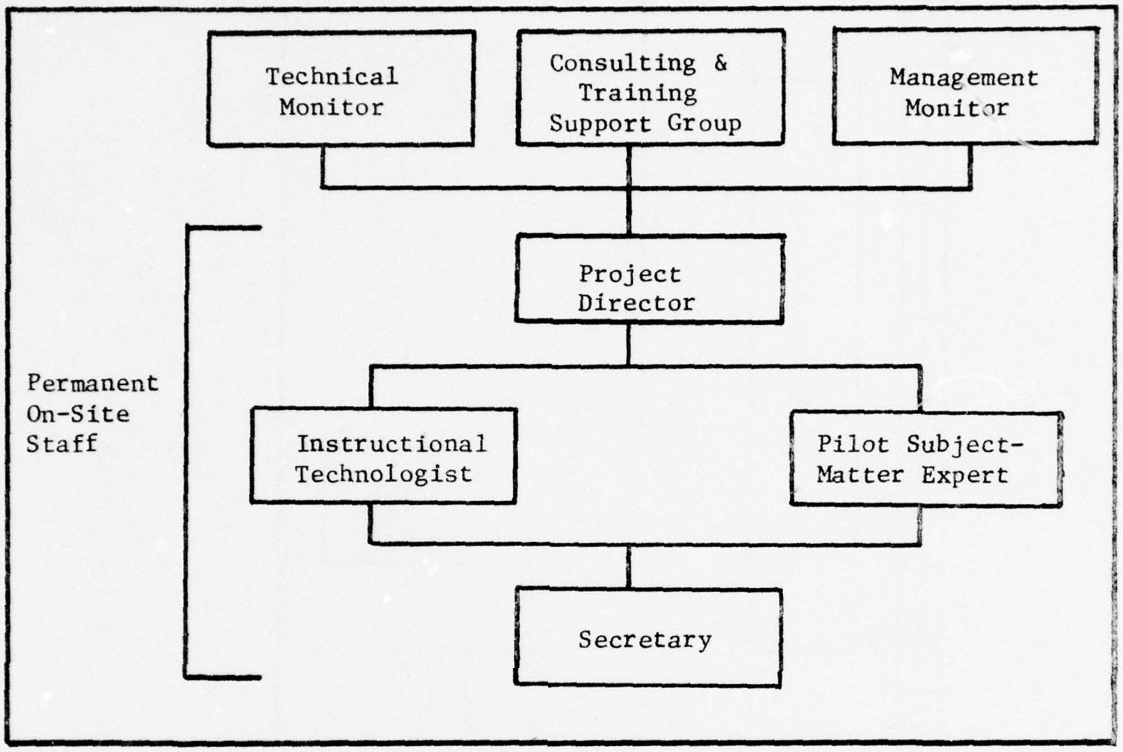

Figure 3. Contractor Project Organization

PROJECT PHASING. The phasing of major ISD activities was planned at the outset of the project as shown in Figure 4. Phase I was contractually defined as a one-year effort.

It should be noted that the analysis of training support requirements--the interaction between ISD and the logistical support system--was included in project phasing. Objectives hierarchy development was overlapped with Job Analysis to avoid idling the VAQ-129 subject-matter experts during the Job Analysis Survey which took place in the second half of the Job Analysis block, and was conducted by questionnaire using Fleet Squadron subject-matter experts. This same principle was followed in overlapping Lesson Specification with Media Selection and Course Sequencing; activities which were believed to require minimal VAQ-129 SME time. It should be pointed out that three training sessions for SME were scheduled, one each at the beginning of the Job Analysis, Objectives Hierarchy, and Lesson Specification blocks.

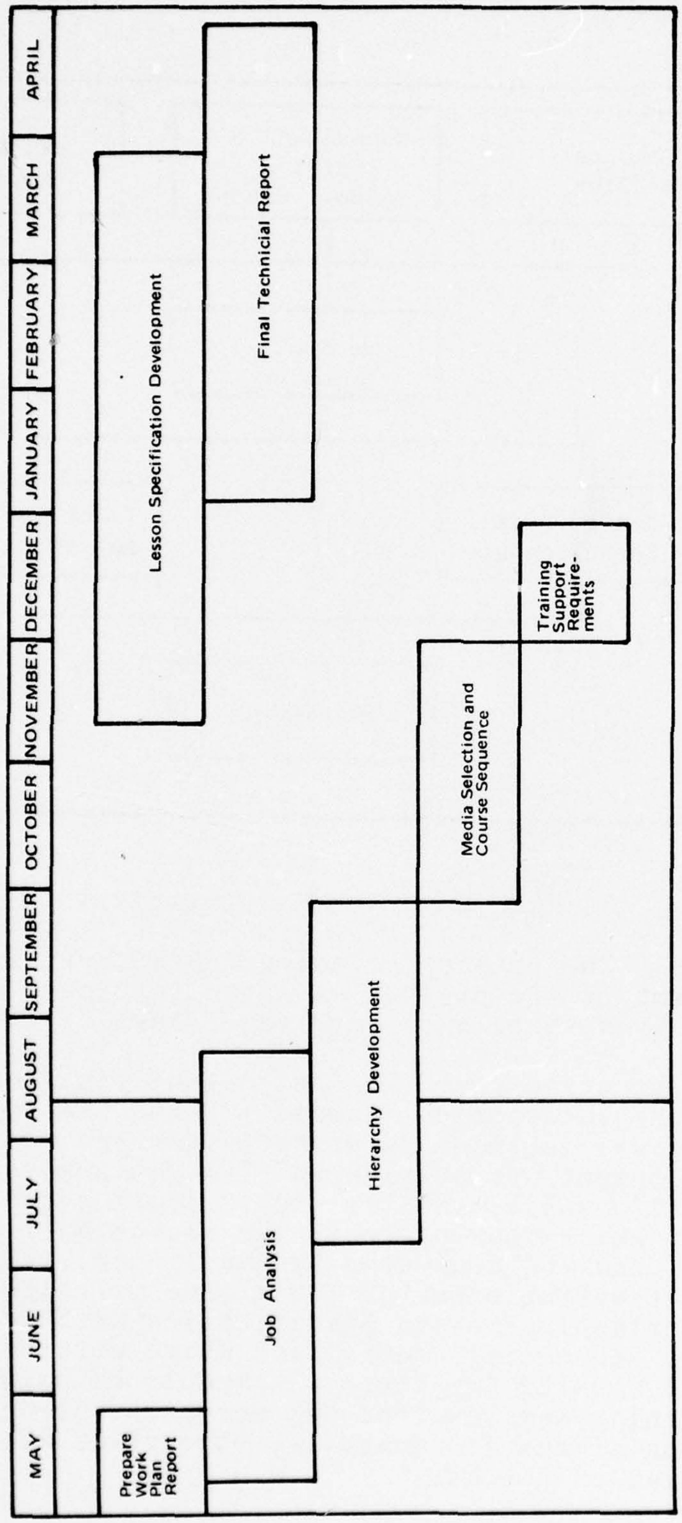

Figure 4. Initial Project Phasing

DETAILED TECHNICAL APPROACH

The basic ISD model summarized in the previous section and in Appendices A and B was elaborated at length in the Project Work Plan which was devised during the first weeks of the project. The technical approach section of the Work Plan, which is included as Appendix B of this report, justified and detailed the specific procedures, techniques, formats, and algorithms to be used in carrying out the major steps in ISD. For a more thorough understanding of the description of step-by-step project activities which follows, this technical approach description should be consulted.

The basic ISD model was even further elaborated during the first few months of the project. The Work Plan identified several areas where basic models and algorithms needed to be made project-specific for the EA-6B ISD effort. These included selection of tasks for training, objectives hierarchy analysis and job analysis survey. Other areas--particularly those involving logistical information--were identified as requiring initial development.

The project-specific Task Selection Model shown in Figure 5 was designed rapidly and was available for use within the first month. The Objectives Hierarchy Analysis algorithm (Figure 6) and the Job Analysis Survey form (Figure 7) were also devised and ready for project use in a very short time.

For purposes of resource requirements analysis, the forms shown in Figures 8 and 9 were developed. The Media Cost/Time Matrix was designed to establish a basis for time and cost comparisons of various instructional media during development, implementation, and revision. The Time Summary Sheet was a simple device for keeping track of all personnel time expended directly on the project.

STEP-BY-STEP PROJECT ACTIVITIES

INTRODUCTION. This section of the report presents a detailed description of the activities conducted during each step of the ISD process. The following categories of information are included for each step:

- A narrative description of events, activities, and accomplishments.
- A detailed account of problems and solutions.
- A description of SME training activities conducted.
- An account of calendar and personnel time consumed.

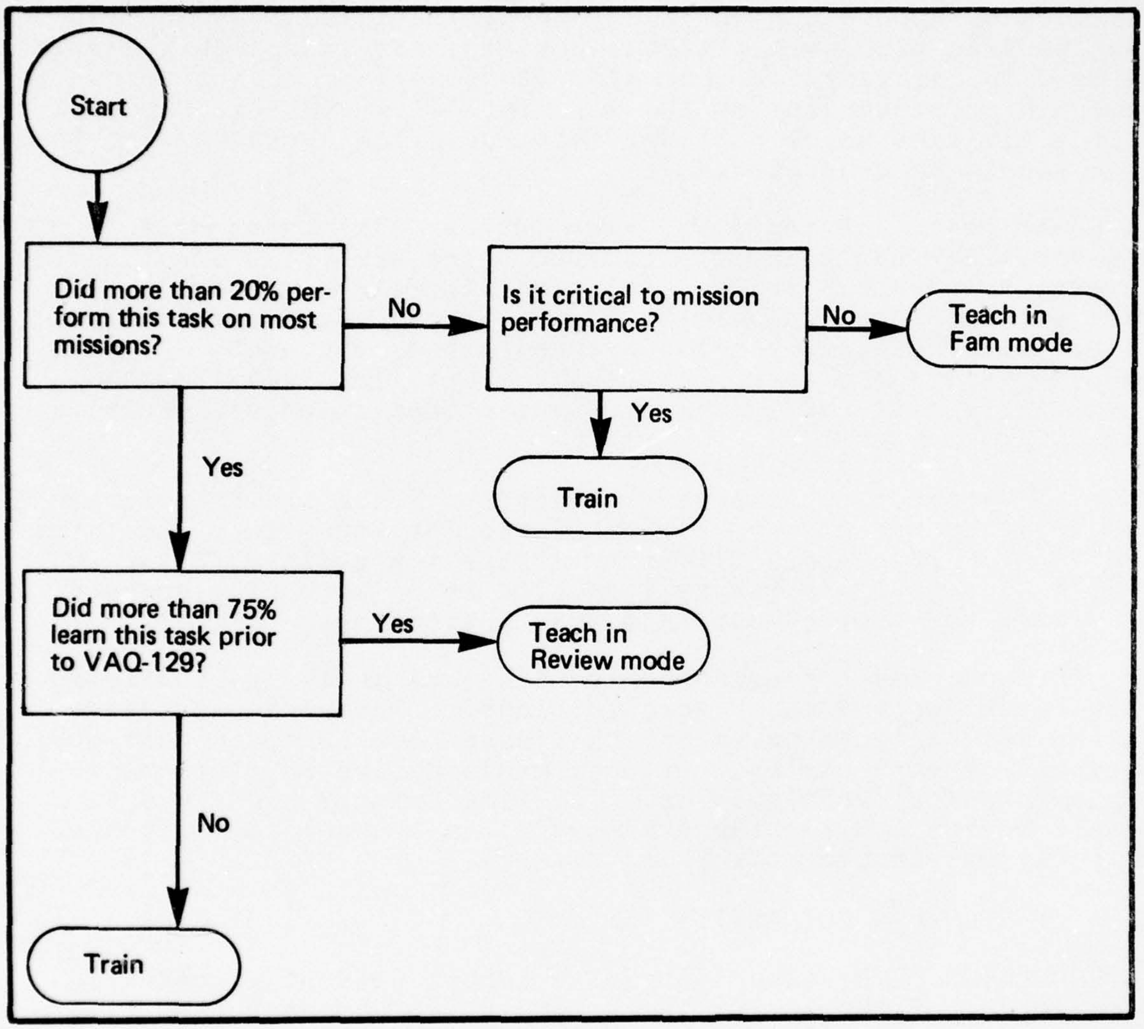

Figure 5. Project Specific Model for Selecting Tasks for Training

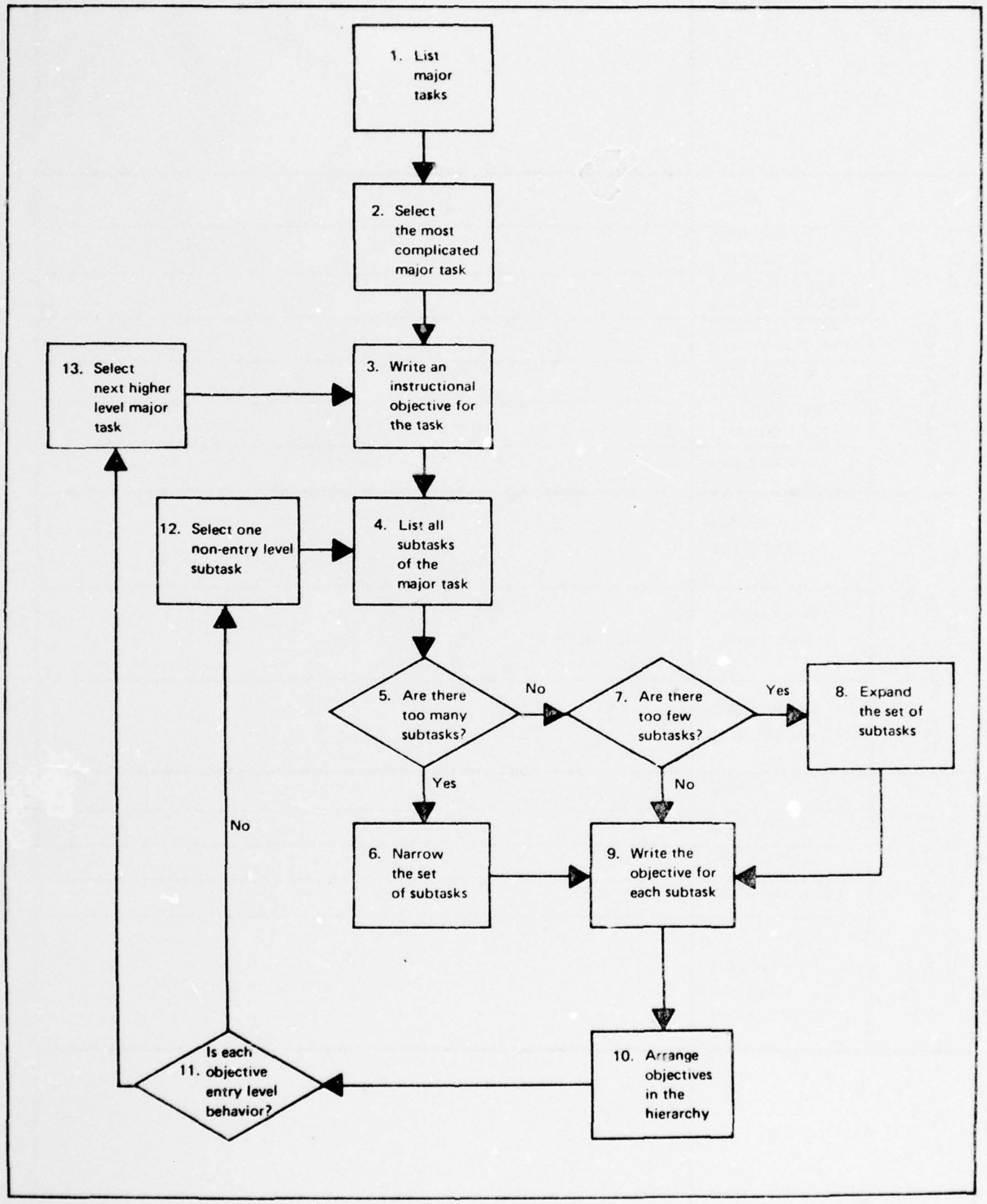

Figure 6. Objectives Hierarchy Analysis Model

TASK	How often do you perform this task as a part of your flight?					How soon after leaving VAQ-129 training did you have to perform this task?			Where did you first learn to perform this task?							REMARKS
	More than once per flight (specify)	Once per flight	Most flights	Few flights	Never	During pre-deployment	During first deployment	After first deployment	Didn't learn	Prior to VAQ-129 training	During VAQ-129 training	Pre-deployment squad training	Post-deployment squad training	Learned on your own	Other	

Figure 7. Job Analysis Survey Form

INSTRUCTIONAL DELIVERY SYSTEMS

		(1) Initial Purchase Price Per Device	(2) Operating Costs		(3) Operating Time (Man-Hours)	(4) Maintenance		(5) Instructor Load			(6) No. Students To View/Use One Copy/Device		(7) Production							(8) Revision						
													(7.1) Materials			(7.2) Time (Man-Hours)				(8.1) Materials			(8.2) Time (Man-Hours)			
			With Amorti-zation	W/O Amorti-zation		Man-Power (Man-Hours)	Costs	Instruct	Monitor	Test	Optimum	Feasible	Master	Duplication	Total Materials	Authoring	Production	Implemen-tation	Total Prod. Time	Master	Duplication	Total Materials	Authoring	Production	Turn-Around	Total Rev. Time
Slide	Slide/Tape																									
	Sound-On-Slide																									
	Random Access																									
Print	Workbook																									
	Worksheet/Checklist																									
Dynamic	Videotape																									
	Film																									
Workbook Plus Audio Track																										
CAI																										
Position Trainer																										
Weapons System Trainer (WST)																										
Aircraft																										

Figure 8. Media Cost/Time Matrix

TASKS	Colyar	Freiheit	Patterson	Penfold	Scott	Simons	Total SME		Hughes	Lindsey	Total IP	

Figure 9. Time Summary Sheet

JOB ANALYSIS.

Activities, Time and Personnel. Four basic activities were conducted during the Job Analysis phase of ISD. These activities were:

- Development of a task listing.
- Preparation, distribution, and analysis of the Job Analysis Survey.
- Determination of project goals.
- Determination of training program resources and limitations.

Each of these activities will now be discussed in more detail.

The largest task completed during Job Analysis was the development of a listing of all tasks performed by each of the EA-6B ICAP crew members. This listing formed the foundation of all subsequent analyses during the ISD process. The procedure used to develop the task listing is outlined in Figure 10. Basically stated, the SME walked through a typical Electronic Counter Measures (ECM) mission step-by-step. The instructional psychologist (IP), instructional technologist (IT), and subject-matter expert (SME) worked together identifying the tasks that had to be completed at each point. A standard outline format was used to show the relationship between tasks.

In some cases, the tasks were identified as pilot-only, or ECM operator (ECMO)-only tasks, while in other cases both crew positions were involved. For many of the items identified, it was questioned whether they were tasks or "subtasks" (i.e., a part of a larger task). A "task" was defined as any sequence of events which has a clearly definable beginning and end point or which produces an observable product. While this definition was only a general guideline, it was sufficient to handle task status determination on a case-by-case basis.

As would be expected, as the task listing neared completion many tasks were identified which needed insertion into supposedly already completed areas. The outline format was flexible enough to handle these insertions with a minimum of reorganization. However, to insure that the numbering and format was consistent throughout, only one person, the IT, was allowed to handle update of the master copy.

In addition to performing ECM missions, EA-6B crews are also required to undertake Electronic Surveillance Measures (ESM) and task force defense missions. Therefore, after the initial version of the task listing was completed for an ECM

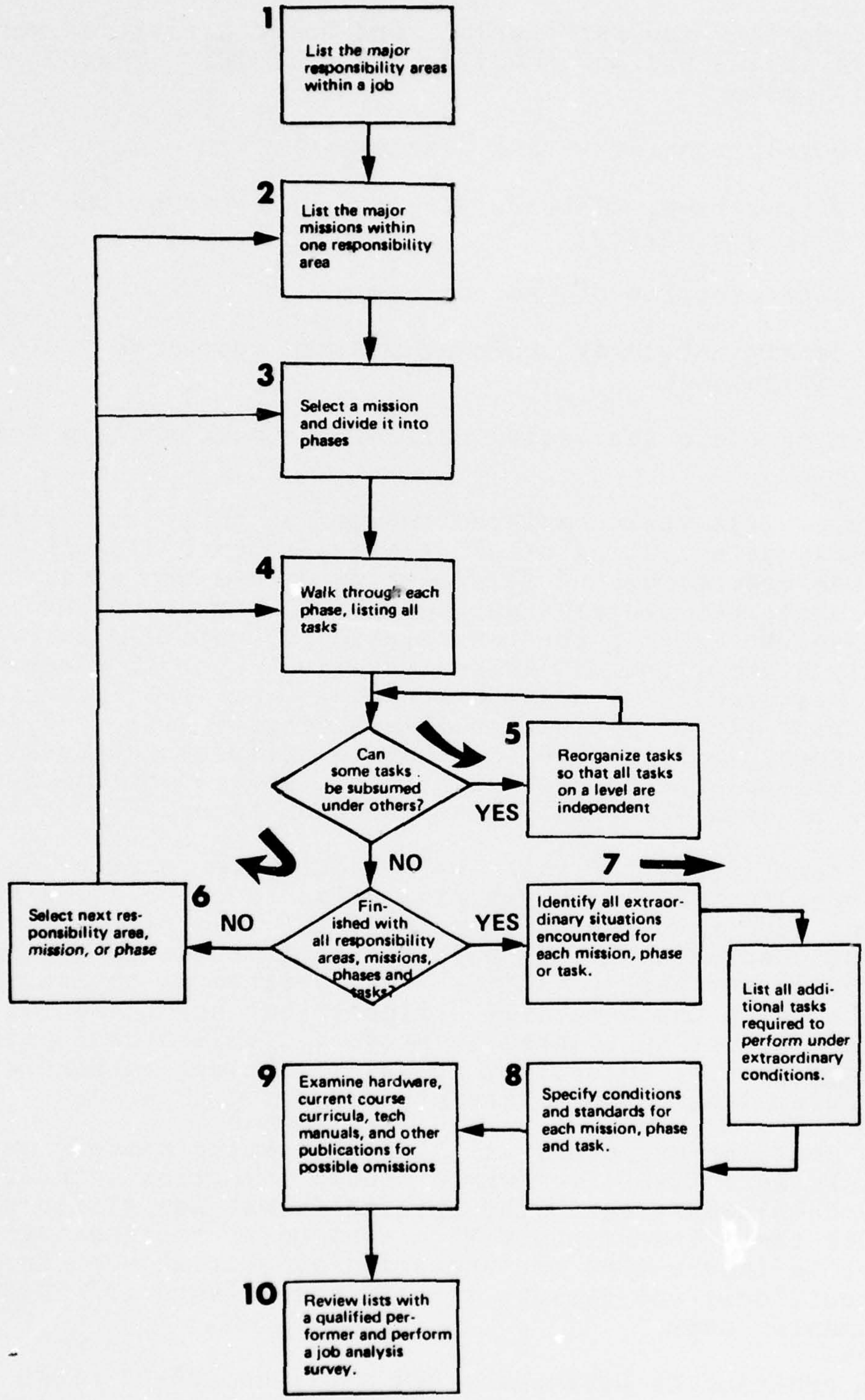

Figure 10. Task Listing Model

mission, the ISD team reviewed it to identify tasks which needed to be added to make the task listing complete for these other types of missions. Several minor tasks were added as a result of this review. The task listing was then reviewed by the ISD team for accuracy and completeness.

The task listing phase of ISD was begun on May 26, 1975, and finished on June 17, 1975, requiring an elapsed time of 17 days. Within this period approximately 216 man-hours of SME time, 35 man-hours of IP time, and 56 man-hours of IT time were logged toward development of the task listing. These data are summarized in Table 6.

Once the task listing was complete for both pilot and ECMO positions, the IP and IT prepared the Job Analysis Survey form for each position. Figure 7 shows the survey form that was used. The tasks identified in the task listing were entered in the left-hand column of this form. The Job Analysis Survey for the pilot position was ten pages long while ECMO was nine pages in length. These surveys were distributed to all cruise-experienced NFO and pilots in the EA-6B community by LT Harold Osterson of COMMATA/VAQWINGPAC. Three of these squadrons were on cruise at the time of the survey, while two of the squadrons were at Whidbey Island, Washington. Surveys were mailed with necessary instructions to deployed squadrons, and were hand-carried to those squadrons at home.

All except one squadron's survey forms were returned within a month and a half from the date that they were distributed. Surveys from the remaining squadron were delayed due to shipboard operations schedules, and were received too late to be included in the data analysis. However, the results of these surveys were in accord with the other data. In all, the data from 17 pilots and 38 NFO were analyzed. For each task and for each question asked about that task, the percentage of persons giving each response was determined. The results of the Job Analysis Survey are summarized in Appendix C of this report. This data was used later in the ISD procedure to select tasks for training. This procedure will be discussed in more detail later in this report.

The Job Analysis Survey was begun on June 12, it was distributed on June 17 and the results were tallied on July 15. The analysis was completed on August 4. The total time spent on this task was as follows:

- 49 man-hours of SME time
- 21 man-hours of IP time
- 13 man-hours of IT time

TABLE 6. ON-SITE PERSONNEL HOURS EXPENDED DURING JOB ANALYSIS

TASK	IP Time	IT Time	SME Time	
			Contractor	Navy
Outline project goals	8	0	4	0
Outline VAQ-129 resources and limitations	22	2	0	2
Develop task listing	35	56	57	159
Prepare and distribute Job Analysis Survey	5	5	16	2
Tally and analyze Job Analysis Survey	16	8	31	0
Prepare Job Analysis Document	6	0	4	0
Attend initial ISD training course	0	21	21	84
Conduct initial ISD training course	42	0	0	0
Prepare for initial ISD training course	78	8	0	0

Another activity which was conducted parallel to the tasks listed above, was the determination of project goals. The success of a project is judged based on how well it meets its predetermined goals. When the project involves several interested organizations, it is possible (even probable) that the project goals for each of these groups are different. These goals may be complementary, independent or even contradictory to one another. Therefore, these goals must be clearly specified for each group so that the project is responsive to the needs of all. If this is not done, it is possible for a project to be viewed as a monumental success for some (those whose goals were met) and as a dismal failure by others (those whose goals were not met).

There were essentially three interested organizations which had either written or understood goals for this project:

- NAVTRAEQUIPCEN
- VAQ-129
- Contractor

These goals have been presented in the Introduction to this report. They were referred to periodically throughout the remainder of the project to insure that the activities conducted and decisions made were responsive to the needs of the interested organizations. Determination of project goals required eight man-hours of IP time, and a small amount of time for personnel interviewed.

Another activity which was conducted parallel to the task listing process was the determination of VAQ-129 present training resources and limitations. It was important that this determination be made early in the project since the curriculum developed and the media decisions made were somewhat affected by this data. For example, the media plan developed for the project had to either use media resources already available in the squadron or specify exactly what hardware purchases had to be made.

To complete this task, the IP contacted and interviewed various personnel in the training squadron. The collection of present resources and limitations data required 22 man-hours of IP time, and small amounts of time from the various personnel that were interviewed.

Training. A five-day training course was conducted in San Diego, California, at the beginning of the task listing phase to introduce all SME to the ISD model used by the Contractor and to give them detailed training to perform a job analysis. Training for each of the other steps of ISD was conducted when that step

began. The classes were taught by two Contractor IPs. The class schedule for this first course is presented in Figure 11. Each SME was given a two-volume set of reference manuals, a set of lecture notes, and a set of handouts.

Problems and Solutions. As a whole, the job analysis phase of this ISD project went fairly smoothly. The required documents were complete, accurate, and ahead of schedule. However, several problems were encountered. Some of these difficulties can be eliminated in future ISD efforts by minor changes in, or additions to the ISD procedure, while others seem to be unavoidable, intrinsic parts of ISD. These problems will be outlined in detail below along with the possible revisions to the ISD procedure.

Task-subtask Distinctions. As was mentioned earlier, some difficulty was experienced in determining the difference between tasks and subtasks. This was not a critical problem for the following reasons. First, the distinction between tasks and subtasks is somewhat arbitrary. Second, the purpose of the task listing is to identify all tasks to be considered for later, more detailed analysis in objectives hierarchies; therefore subtasks in the task listing would be used during the next phase of ISD.

It is expected that this problem is intrinsic to the ISD process, and as such would not be remedied by alteration of the model. The only suggestion that is made for future ISD projects is that guidelines for task-subtask distinctions be established early on a set of test cases, and that these guidelines be used throughout to insure consistency.

Insertion of Tasks. Also mentioned was the problem of inserting tasks into a supposedly completed portion of the task listing. This problem also seems intrinsic to ISD due to the iterative nature of the process. The outline format was fairly flexible and the additions could be handled with a minimum of trouble.

Identification of Peripheral Responsibilities. The basic procedure used to identify tasks was to walk through a typical mission, and this was adequate to determine the major crew responsibilities. However, it was discovered much later that pilots have a few unspoken peripheral responsibilities. Specifically, it is expected that the pilot be able to field questions any time, anywhere concerning the employment of the EA-6B. For example, they are expected to know whether the EA-6B can handle a specific threat, and if so, how. While this task could best be handled by an ECMO, pilots are expected to know this information in order to enhance their ECM credibility in other aircraft communities.

MONDAY	
8:30	Course Introduction
9:00	Assumptions underlying the Systematic Approach to Instructional Development
9:45	Break
10:00	A closer look at concepts
11:30	Lunch
1:00	A closer look at rules
1:45	Break
2:00	Job analysis, selecting tasks for training
2:45	Break
3:00	Behavioral objectives, and objectives hierarchies
TUESDAY	
8:30	Generalities, examples, practice, and helps
9:15	Break
9:30	Strategy planning I
10:15	Break
10:30	Strategy planning II
11:30	Lunch
1:00	Method/Media selection
1:45	Break
2:00	Course sequencing, and division into lessons
3:00	Break
3:15	Lesson Specification Documents
WEDNESDAY	
8:30	Lesson production
9:30	Break
9:45	Test production
10:45	Break
11:00	Formative evaluation
11:30	Lunch
1:00	Instructional systems management
1:45	Break
2:00	Questions and answers
THURSDAY	
8:30	Job analysis, a detailed look
9:30	Break
9:45	Group exercise
11:30	Lunch
1:00	Review and critique
2:00	Break
2:15	Individual exercise
FRIDAY	
8:30	Review and critique
9:30	Individual assignments

Figure 11. Course Schedule for Initial Training of Subject-matter Experts

To insure that peripheral tasks such as these are identified early, it is suggested that Step 1 in the task listing algorithm, Listing of Responsibilities, be emphasized during this procedure.

Final Program Characteristics. Project goals outline the expectations each organization has for the project. The analysis of assets and limitations outlines the constraints existing in the training environment. These two pieces of information implicitly define a set of characteristics that the final training program must possess to meet the project goals, but stay within outlined constraints. To increase the effectiveness of the ISD model, it would be beneficial to make these final program characteristics explicit. Therefore, it is recommended that a suitable section be added to required documentation early in the project.

Completing the Job Analysis Surveys. The Job Analysis Survey was a nine to ten page survey form with approximately twenty entries per page. The form required one to one and one-half hours to fill out thoroughly and accurately. Because of the length, it was found that some of the persons surveyed were less than careful in completing these forms. Only a few inconsistencies of this nature were found, and they had no substantial effect on the subsequent use of the document to select tasks for training. However, it is suggested that the survey be conducted using an interview format in future ISD projects. In this situation, an interviewer would sit down one-on-one with a crew member and ask him every question on the survey. If any inconsistent answers are encountered, the interviewer has the advantage of immediate access and can gain more information at that time.

Tallying the Job Analysis Survey. The size of the Job Analysis Survey has already been outlined. In all, approximately 50 people were surveyed. This resulted in a very large tallying and data reduction task. Because this task was completed by hand on the present project, it is expected that a few small calculational errors were made. To avoid this on future projects it is suggested that a response form be developed which can be scanned and summarized by computer. This would be a relatively simple task which would result in a smaller manpower requirement, and fewer data analysis errors.

SELECTION OF TASKS FOR TRAINING.

Activities, Time and Personnel. The selection of tasks to be trained was a relatively small step in the ISD process. For the purposes of this project, the general algorithm was modified so that decisions could be more clearly tied to the data collected in the Job Analysis Survey. This modified decision model is shown in Figure 5. This model formed the basis for determining which tasks would be included in the final training program.

The selection of tasks for training procedure was conducted by the IP in conjunction with the SME, where necessary. As can be seen in Figure 5, two of the three task selection decisions were made by referring to only the summary of the Job Analysis Survey. For questions not answered in this way, the appropriate SME was consulted on a case-by-case basis. Once this procedure was completed, all task selection decisions were reviewed by VAQ-129 SME to insure accuracy and completeness. The results of this procedure were used to directly determine the tasks to be addressed during hierarchy development. They came into play again during course sequencing as one input to determining the proper ordering of tasks and objectives.

The entire task selection procedure took one day and required about four man-hours of IP time and a small amount of SME time.

Training. No training was provided by the contractor for this phase of ISD since it was such a small procedure and was conducted by the IP with little required assistance from SME.

Problems and Solutions. No problems occurred during the task selection phase of ISD. It was beneficial to use a specific task selection decision model which was tied to Job Analysis Survey data. Therefore, it is suggested that future ISD projects use specific decision models similar to the one used in this project.

It may be critical (or desirable) in future ISD projects that all decision points of the task selection decision model be data-based, rather than relying on the judgment of SME. If this is the case, then consideration should be given to including questions on the Job Analysis Survey which correspond to all decision points. In the case of the EA-6B project, this would have required the addition of a question on the Job Analysis Survey related to the criticality of each task.

OBJECTIVES HIERARCHY DEVELOPMENT.

Activities, Time and Personnel. The next major task in the ISD process was objectives hierarchy development. A hierarchy is a visual layout of the structure of component objectives which support task performance. It shows subordinate, co-ordinate and super-ordinate relationships between supporting objectives. The time is taken to develop objectives hierarchies because the procedure is a systematic way to determine what the student must learn in order to perform his job. This is in contrast to a more traditional approach which focuses on "what do we want to teach." A training program developed from objectives hierarchies is much more likely to be complete, job and task oriented, and free of irrelevant learning requirements.

The procedure used to develop objectives hierarchies is outlined in Figure 12. As can be seen from this diagram, a major job task is first selected for analysis. The subtasks and required decision points are all identified. A behavioral objective is then developed for each. The objectives are next arranged into a hierarchy format. This analysis procedure continues until every task has been analyzed down to the student entry level behavior.

Once this initial analysis procedure was completed, all hierarchies were reviewed by SME who had not done the previous work. During their review several new tasks were identified and the organization of parts of the hierarchies was altered. In addition to this review, project SMEs reviewed all available course curricula, qualifications manuals, and engineering documents to identify any other tasks that might have been overlooked.

Formatting and numbering conventions were established early in the process for completeness and ease of reference. A detailed explanation of the organizational system can be found in Appendix D of this report, which also contains sample objectives hierarchies. To insure that formatting and numbering was consistent throughout, only one person, the IT, was allowed to update the master copy.

The form used for recording the behavioral objectives is shown in Figure 13. For the most part, the form is self-explanatory. Columns labeled Q1, Q2, Q3, Q4, Q5 were used to record answers to the five questions later used for media selection purposes. Media selection is discussed in more detail in a later part of this section of the report. The columns labeled C, U, L, S were originally intended for use during course sequencing. However, these columns were not found to be useful for that purpose.

Development of objectives hierarchies was begun on June 19 after two days of training, and the majority of the hierarchies were completed by early October. The few remaining hierarchies required technical hardware data and were finally completed by November 12.

A breakdown of the time spent to complete each of the tasks in the hierarchy development phase is presented in Table 7. The total manpower required was 122 man-hours of IP time, 358 man-hours of IT time, and 408 man-hours of SME time.

Training. Two days of training were provided prior to the start of hierarchy development. Because of its close similarity to the task listing procedure, little formal training was required. During the morning of the first day the general analysis procedure was outlined in some detail, and several illustrative examples were presented and discussed. The basic formatting

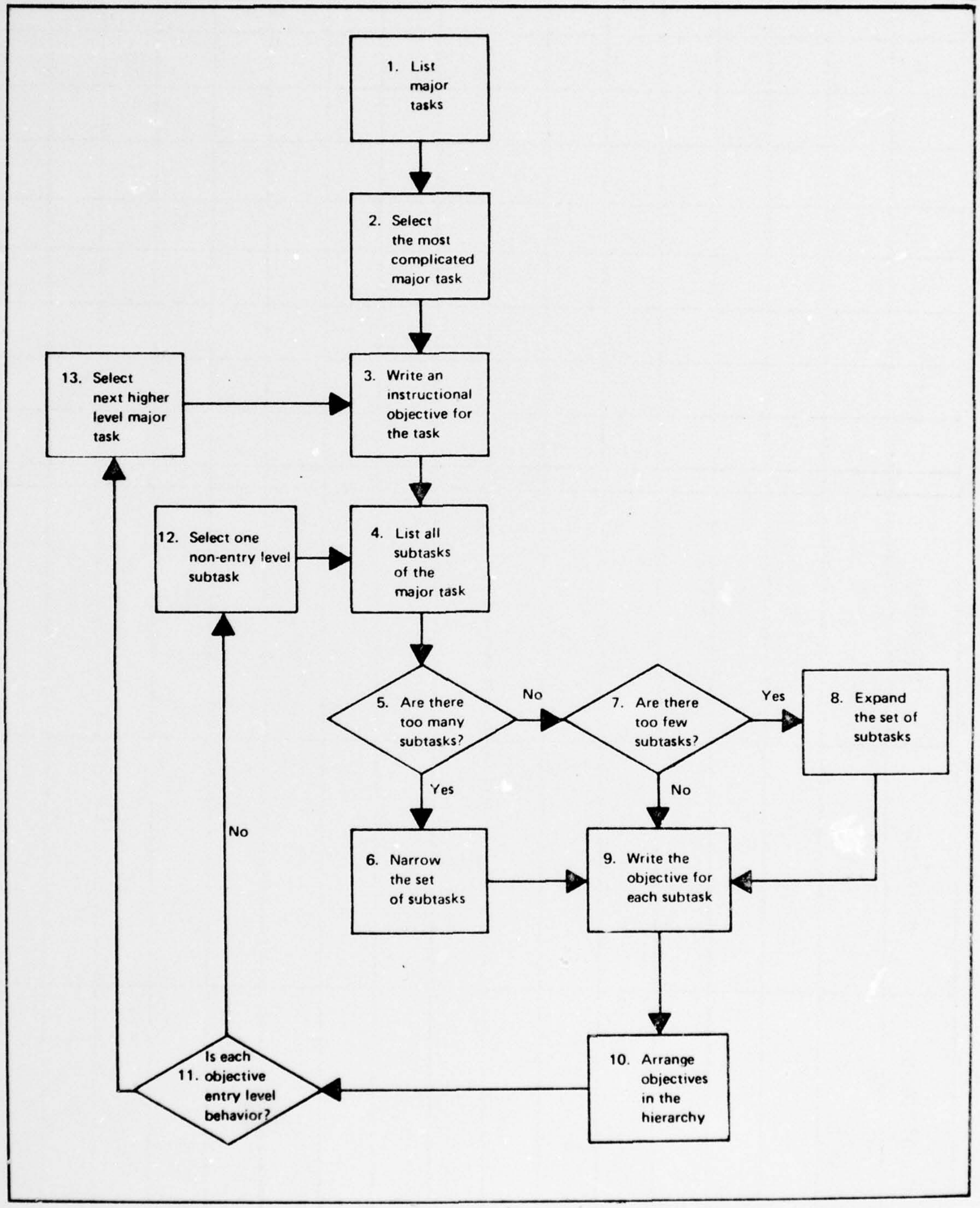

Figure 12. Objectives Hierarchy Analysis Model

OBJ #	CONDITIONS	BEHAVIOR	STANDARD	Q1	Q2	Q3	Q4	Q5	Time	C	U	L	S

Figure 13. Instructional Objectives Recording Form

TABLE 7. ON-SITE PERSONNEL HOURS EXPENDED DURING HIERARCHY ANALYSIS

TASK	IP Time	IT Time	SME Time	
			Contractor	Navy
Attend hierarchy development class	0	7	7	28
Present hierarchy development class	14	0	0	0
Develop hierarchies	122	358	228	180
TOTAL for phase	136	365	235	208

conventions were also outlined. Guidelines for the preparation of complete behavioral objectives, which had been covered in detail in the first training session were again reviewed. The afternoon of the first day and the entire second day of training was spent developing EA-6B ICAP objectives hierarchies. During this guided practice session the formatting and numbering conventions were implemented, and many of the higher level hierarchies were developed. This work formed the basis of all subsequent hierarchy development.

Problems and Solutions. The hierarchy analysis phase of this ISD project went very smoothly. Few problems were encountered. During the analysis procedure several specific techniques and hierarchy structures were developed that may help to streamline the hierarchy analysis procedure in future. Both the problems and the suggested revisions to the ISD procedure will be outlined in detail below.

Analysis of Tasks for a Non-operational Aircraft. The one problem to be discussed is inherent in the analysis of crew tasks for an aircraft that has never been flown. In task areas in which the ICAP version of the EA-6B aircraft was different from the XCAP and/or Standard versions, the military requirements documents and engineering documents had to be referred to in much greater detail. As a result, the structure of the hierarchy changed periodically to reflect new information from the hardware contractor.

It is expected that this problem will always be incurred when working with non-operational weapons systems. This problem could possibly be alleviated somewhat by early involvement in the weapons system design process, and by reference to human factors design data.

Pruning of Hierarchies. The general task analysis model specifies that all subordinate subtasks should be included in the hierarchy. In practice, however, it was found that some of these lower level objectives needed to be deleted or "pruned" from the hierarchy for either or both of the following reasons:

- The behavior required was so trivial that it was unnecessary and inefficient to learn it by itself.
- The objective required behaviors which were clearly at student entry level.

It is recommended that this "pruning" procedure be added to the hierarchy development process by revising the algorithm appropriately.

Addition of Summarization Objectives. Many of the tasks identified during objectives analysis were composed of a very large number of subtasks of procedural steps. In such cases, it was found useful to add another objective requiring the student

to state the procedure for performing the task. What this accomplished was to insure that the instruction for the task would not only teach all of the individual steps, but would also teach toward remembering all of the steps in their correct order. This summarization objective was not required for tasks having a small memorization component. It is recommended that this technique also be incorporated into the ISD model for future use.

Systems Introduction Hierarchy Structure. During the hierarchy development procedure it became apparent that tasks to be analyzed could be sorted into several categories. Within each category the identification of subtasks and development of the hierarchies tended to follow a systematic pattern or structure. One of the standard hierarchy structures that was identified during this project was the "systems introduction structure."

When a major portion of a job requires interaction with a complex hardware system, it is desirable that the individual be familiar with the basic relationships between the system and its related subsystems and components. The purpose of a systems introduction structure is to organize and specify exactly which systems, subsystems, and systems components must be introduced to a student who will be working with a complex piece of machinery. The basic structure of this type of hierarchy is shown in Figure 14. The complex hardware system is broken down into its major systems. Each of these systems is then divided into its subsystems and, finally, the components of each subsystem are identified.

The lowest level objective in the hierarchy for each system requires the student to state the names of the subsystems and describe in general terms how they interrelate.

The next level of objectives covers each of the subsystems, using one objective per subsystem. The objective requires the student to specify the input, output and operation of each subsystem component. The components to be covered are specified in the standard of each objective.

The next higher level of objective requires the student to state the limitations and normal operating parameters of the system.

Finally, the top level objective is a "header" objective which requires the student to put all of this information together.

Behavior Approximation Hierarchy Structure. Sometimes tasks performed on the job are dangerous (but critical) to the mission, or are extremely expensive in terms of the consumption of soft resources. In such cases, it is advisable to approximate the task in a less dangerous, and/or less expensive mode in training.

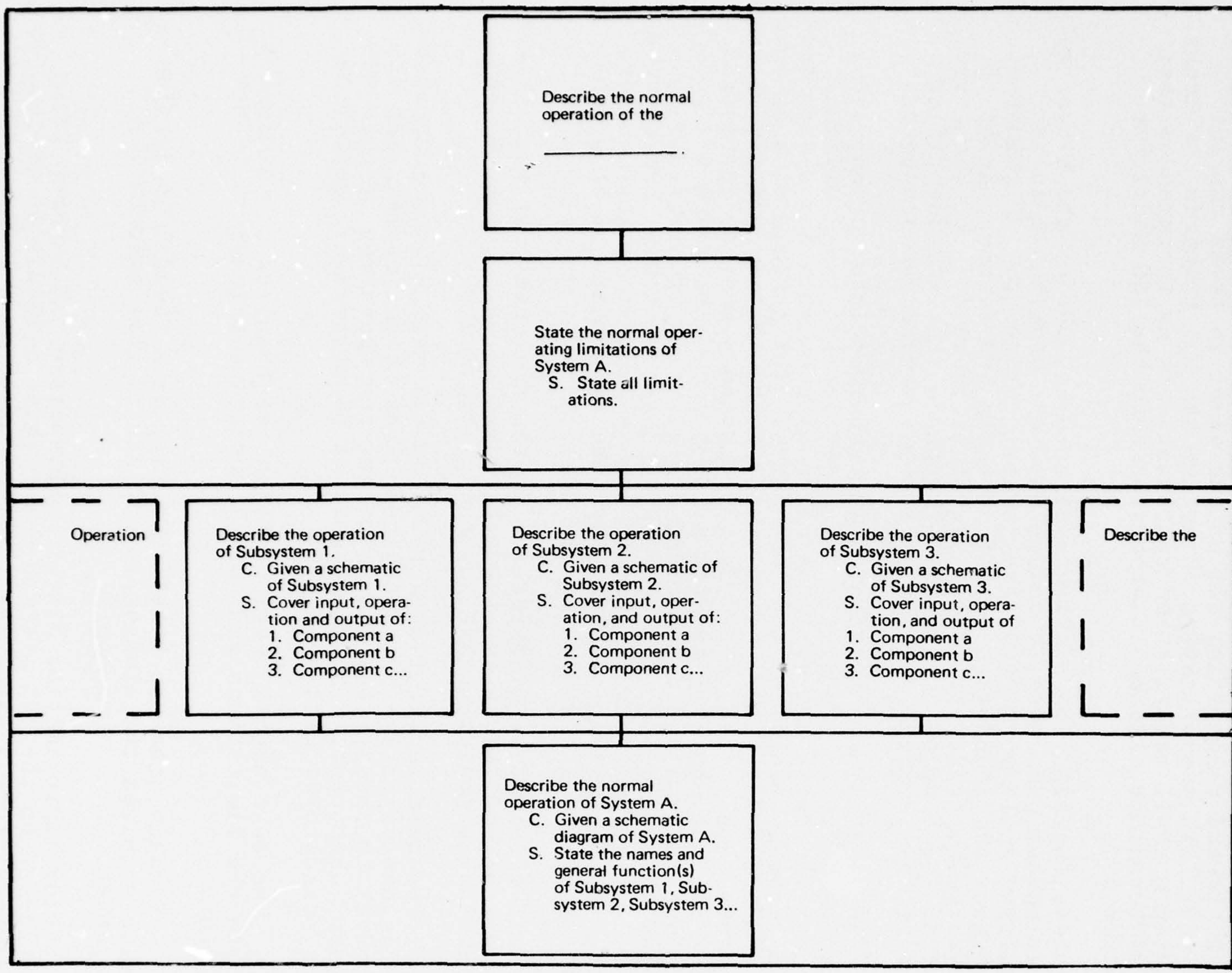

Figure 14. Systems Introduction Hierarchy Structure

If this is done, the hierarchy structure shown in Figure 15 should be used.

The terminal task required for actual job performance is still specified in the top box of the hierarchy. But under this task an objective is added requiring the student to perform it under simulated or degraded (safer and/or less costly) conditions. The task structure below this is the same as for non-dangerous (or inexpensive) tasks except conditions statements in the objectives are directed toward the simulation rather than the actual task.

SEQUENCING AND GROUPING OF OBJECTIVES.

Activities, Time and Personnel. Once objectives hierarchies were completed, the procedure of sequencing the objectives and grouping them into units, lessons and segments began. The first step in this procedure was to determine the numbering system to be used. This was done by the IP based on previous experience with similar development projects. Next, the hierarchies were examined to determine tentative unit content for the pilot and the ECMO courses. A unit typically had a very high level objective, and consisted of all of the objectives underneath it in the hierarchy. Each of these tentative units was then broken down into tentative lessons. Each lesson typically had a medium complexity level objective, and consisted of all of the objectives underneath it in the hierarchy. Next, beginning with the first lesson of the first unit in each course, the within-lesson sequencing began. This typically involved identifying each objective as a "segment" of instruction. As segments were sequenced within lessons, misplaced objectives were identified, and unit and lesson boundaries were changed to better incorporate these objectives. This process was carried out by the IP and IT, working in close conjunction with the appropriate SME.

Once the units, lessons and segments had been identified, a preliminary set of media decisions was made (see the following section for details). Based on this preliminary data, a few lessons were slightly restructured to consolidate objectives requiring the use of simulators or aircraft.

Next, using the objectives hierarchies and the listing of units, lessons and segments, a set of unit and lesson maps was developed for each course. Sample unit and lesson maps are included as Appendix E of this report. This activity was carried out by the IT in conjunction with necessary SME.

Finally, all maps and objectives were reviewed by SME who were not previously involved with the ISD project. As a result of this review, several minor changes were made in the maps.

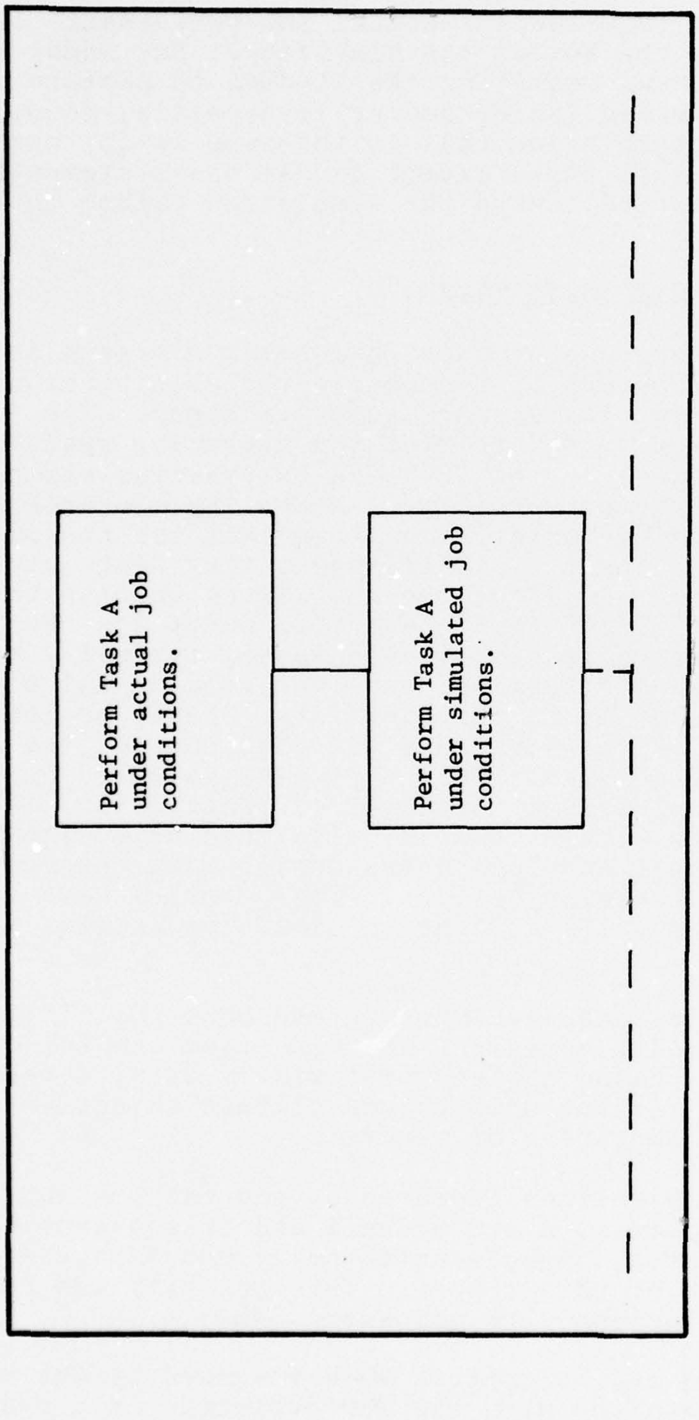

Figure 15. Behavior Approximation Hierarchy Structure

The course sequencing procedure was begun on September 10, and it was completed on December 20. A detailed breakdown of the time required for each task is shown in Table 8. The total time spent for this entire phase was 115 man-hours of IP time, 258 man-hours of IT time, and 376 man-hours of SME time.

TABLE 8. ON-SITE PERSONNEL HOURS EXPENDED DURING GROUPING AND SEQUENCING OF OBJECTIVES

TASK	IP Time	IT Time	SME Time	
			Contractor	Navy
Sequence and group objectives	59	69	65	82
Prepare lesson maps	56	189	214	15
TOTAL for this phase	115	258	279	97

Training. No formal training was provided for this phase of the ISD procedure since much of the work was done by the project IP and IT with SME being involved on an as-needed basis.

Problems and Solutions. The course sequencing phase of this ISD project was conducted with few difficulties. The output was clear, complete, and defensible, and forms the basis for an extremely well-organized syllabus for the pilot and ECMO courses. While this phase took slightly longer than originally scheduled, this had no significant effect on the other phases of the project. Four specific problems were encountered which will be discussed in detail.

Review of Existing Course Syllabus. As within-lesson sequencing progressed, it became apparent that certain additional sequencing preferences and requirements could be identified by examining the sequencing of the existing EA-6B XCAP course syllabus. These sequencing requirements fell into the following three basic categories:

- Restrictions due to squadron policy (e.g., no students will fly until having passed a written emergency procedures exam).
- Requirements and preferences to facilitate personnel and resource scheduling.
- Sequencing preferences to increase student affect and motivation.

None of these sequencing requirements can be identified by examination of the objectives hierarchies but all are useful to insure the quality and feasibility of the final course sequence. It is recommended that in future ISD projects the existing course syllabus be examined to identify these types of sequencing requirements and preferences.

Interaction with Media Selection Process. The course sequencing process and the media selection procedure must be viewed as interacting procedures. The unit and lesson structures are affected somewhat by the media decisions, and media decisions are altered based on course sequencing and grouping. While this fact was realized before the sequencing phase began, it was found that the procedures used did not fully handle this interactive requirement. While no substantial recommendations can be made based on the present study, it is urged that future ISD models will incorporate procedures which make these interacting steps more efficient to carry out.

Time Required to Fill Out Maps. Originally, the preparation of unit and lesson maps and objectives had been viewed as a relativley minor part of course sequencing. However, as can be seen from Table 8 this turned out to be a rather time-consuming process. This fact must be taken into account during the scheduling of future ISD projects.

Review Requirements. The final step in the course sequencing procedure was a thorough review by personnel not connected with the ISD effort. This review took a long time to complete because appropriate personnel were not readily available. This is not a problem which should be expected on other ISD projects if personnel are identified and notified early that the review requirement exists.

MEDIA SELECTION.

Activities, Time and Personnel. A detailed description of the media selection procedure used on this project is contained in the Training Support Requirements Document (Contract Data Item No. 0005), portions of which are included as Appendix F of this report. The following basic procedure was followed. A general media selection model was modified to meet the specific needs of this project. A computer program was next developed to allow

objectives to be sorted through the selection model automatically. The course, unit, lesson, and segment number along with the answers to five media selection questions were coded onto computer cards for each objective. The program output was a set of first level media decisions for all objectives. The first level media decisions were essentially idealized and unconstrained. They provided a listing of the optimal choice and acceptable alternative media choices for each segment. At this stage of the process, lessons were quite likely to contain segments calling for a variety of instructional media. This was considered unfeasible. In order to make the instruction within each lesson more uniform, second level media decisions were made. During this process a single optimal presentation medium was selected for the entire lesson. Second and third choice media were also identified for each lesson. This process also resulted in a few minor lesson reorganizations. Next, four sets of assumptions were made about the media mix that would eventually be judged by the Navy to be feasible and supportable for the EA-6B project. At one extreme it was assumed that an ideal media mix, including computer-assisted instruction (CAI), would be available. At the other extreme it was assumed that nothing beyond what was already on hand would be made available.

For each of the four assumptions a media plan was developed. Each of the four plans assigned the most effective media to each lesson within the restrictions imposed by its matching assumption. The four media plans were then costed out in terms of the personnel, equipment, facilities, and support services that were required during development, implementation, and ongoing evaluation and revision. It was left to the Navy to determine which of these plans would be implemented in the event of a Phase II program.

Data pertinent to the four plans are shown in Appendix F.

The media selection process and subsequent production of the Training Support Requirements Document was conducted by the project IP with help from the SME where ambiguities arose because of subject-matter questions. Table 9 provides a listing of the time required for each task in the media decision phase. This phase was begun on September 25 and was finished on December 24. The total time required was 152 man-hours of IP time, and a small amount of SME time.

Training. No training was provided for this step of the ISD procedure since all of the work was handled by the project IP.

TABLE 9. ON-SITE PERSONNEL HOURS EXPENDED ON MEDIA SELECTION

TASK	IP Time	IT Time	SME Time	
			Contractor	Navy
Develop media selection program	20	0	0	0
Run media selection program	20	0	0	0
Prepare training support requirements document	112	0	0	0
TOTAL	152	0	0	0

Problems and Solutions. The media selection procedure and preparation of the Training Support Requirements Document went as planned. The outputs were adequate and more than satisfied their original purpose. However, there are several modifications that could be made to this phase of the ISD procedure to make the process more efficient and the product more useful. Several of these modifications are outlined below.

Sensitivity of the Media Decision Model. The computerized media decision model used in this project was very useful for sorting objectives into appropriate media with one exception--objectives which required actual "hands on practice" were all sorted into a single category. These objectives later had to be sorted on a case-by-case basis into several categories representing the various trainers and the actual aircraft.

For future ISD projects, it is suggested that the media selection model be made more sensitive to different "hands on practice" requirements. This could be done with relative ease by adding a sixth media selection question, which would deal with the real-time interactive requirement of the objective.

Lack of Direction Concerning Plan Selection. When developing the guidelines for each of the four alternative media plans, there was only minimum guidance provided concerning which plans would be most useful to consider. That is, when the four sets of restrictions were developed there was not enough interaction between the contractor and the clients. More discussions should have been conducted with NAVTRAEQUIPCEN and VAQ-129 to determine which sets of restrictions would produce media plans most beneficial for their use. This lack of information exchange was in part due to the newness of the procedure.

To avoid this problem in future ISD efforts, it is suggested that the contractor and the client work closely together to develop the guidelines (i.e., the sets of media restrictions) for which media plans should be developed. This could best be done as a parallel activity to hierarchy development. In this way all necessary data would be available in plenty of time for use during the media selection procedure.

Computerization of the Media Selection Process. The first level media decisions were made using a computer program. All other decisions and costing calculations were made by hand. It became clear during this process that this entire procedure could be computerized with relative ease. It would be expected that media decisions made in this manner would have to be reviewed to identify special cases which occur. However, for relative cost comparison purposes, a computer program would be invaluable. It would also be possible to determine development cost for any number of alternative media plans. Therefore, it is recommended that consideration be given to the development of such a program either as a part of the future ISD project or as an independent effort to be used in ISD.

LESSON SPECIFICATION.

Activities, Time and Personnel. As soon as the grouping and sequencing of objectives was completed, the production of lesson specifications was begun as a parallel activity to media selection. A lesson specification is a document which is produced by SME for every objective in each course. This document actually contains some of the critical instructional components. Others are specified in sufficient detail to permit their completion with relative ease. The strategy for the segment is outlined in detail. The reason that specifications are written prior to production of the actual lesson materials is that they require the SME to carefully determine and specify the critical instructional components. This step might be lacking if he proceeded right into lesson production. Also, because the critical content components are specified, it allows the SME to turn the actual writing of the lesson materials over to a less experienced, less knowledgeable author.

This phase of development began with a two-day training program. At its completion, SME began producing lesson specifications under close supervision of the project IP and IT. To insure that lesson specifications were complete and of uniform format, the SME were each given the formatting guide shown in Appendix G of this report. This guide outlined both the content categories to be included and the format to be used during preparation of lesson specifications. Once the specifications were authored they were reviewed by the IP and/or the IT, and then by another SME not directly involved in the ISD project. Based on these reviews, the lesson specifications were revised and reviewed again. When all revisions were finished, the lesson specifications were typed.

In general, the order of production of the lesson specifications corresponded to the sequence of the pilot and ECMO courses. However, the pilot lesson specifications deviated slightly from this order. After the systems introduction (Unit 14) was completed the emergency procedures (Unit 9) specifications were written, followed by the other units (Units 13, 12, 11, 10, 8, etc.) in order. This was done because the emergency procedures unit tied directly to the systems introduction unit, and as such the SME felt more comfortable writing these units one after the other.

The lesson specification phase of ISD was begun on October 6, and, due to lack of adequate SME support had not been completed in the writing of this report. A detailed breakdown of the time and cost expended on each of the tasks in this phase to date is presented in Table 10.

While not all of the lesson specifications have been completed for this project, it is possible to give a fairly clear estimate of the average man-hours required to prepare them. Table 11 presents a listing by author of the number of specifications produced, the total time spent, and the average time per segment. As can be seen from the table, the average time per segment ranges from 3 hours to 50 hours, with the overall average being 5.5 hours.

Sample Lesson Specifications are shown in Appendix H.

Training. At the beginning of this phase, a two-day training course was given to all SME who were then available to assist with production of lesson specifications. The course was taught by two Contractor IP and an IT. An outline of the class schedule is shown in Figure 16. Each student was given a workbook entitled Lesson Specification Course to be used throughout the class, as well as on the job. At the completion of the class, each student was also given the lesson specification formatting guide shown in Appendix G.

TABLE 10. ON-SITE PERSONNEL HOURS EXPENDED ON LESSON SPECIFICATION

TASK	IP Time	IT Time	SME Time	
			Contractor	Navy
Develop lesson specification course	220	13	7	0
Present lesson specification course	30	0	0	0
Attend lesson specification course	0	11	17	88
Develop lesson specifications	49	428	319	670
TOTAL	299	452	343	758

TABLE 11. HOURS SPENT BY SME IN PRODUCTION OF LESSON SPECIFICATIONS

SUBJECT MATTER EXPERT	TIME SPENT (in mh)	NUMBER OF SEGMENT SPECIFICATIONS PRODUCED	AVERAGE (mh/seg)
McSherry	105	15	7
Sale	90	9	10
Sullivan	60	6	10
Campbell	123	19	6.5
Rooney	100	2	50
Heburn	72	16	4.5
Morrelli	120	5	24
Patterson (Contractor)	319	105	3
TOTAL	989	177	5.5

MONDAY	
8:30	Review of Systems Approach and of present project
9:30	Break
9:45	Basic concepts underlying lesson specifications
11:30	Lunch
1:00	Preparing generalities
2:30	Break
2:45	Practical exercise
TUESDAY	
8:30	Preparing algorithms
10:15	Break
10:30	Preparing mnemonics
11:30	Lunch
1:00	Preparing examples and practice items
2:30	Break
2:45	Practical exercise
WEDNESDAY	
8:30	Preparing instance specifications
10:00	Break
10:15	Preparing instance specifications (cont)
11:30	Lunch
1:00	Practical exercise

Figure 16. Outline of Lesson Specification Course Given to SME

As production of lesson specifications continued several SME were taken off of the project, and new ones were assigned. These new SME were trained on an individual basis. They were first given a short brief about the history of the project and the rationale for the ISD model being used. They were given an explanation of many of the basic terms and concepts involved in lesson specification production. They were told to read the Lesson Specification Course workbook. The IP and the IT were available to answer any questions the SME had during their reading. Upon completion of their study of the workbook, they were then given the Lesson Specification Formatting guide, and they began closely supervised production of lesson specifications.

Problems and Solutions. Production of lesson specifications began well ahead of the original project schedule, and progressed well for a short time. However, several serious problems developed which significantly slowed production. These problems will be discussed in detail below.

Insufficient SME Resources. Early in the production of lesson specifications it became apparent that there was not a sufficient number of SME working on the project to handle the volume of lesson specifications required. Those Navy SME who were assigned had other auxiliary duties which made it impossible for them to devote adequate time and effort to the production task. Several attempts were made to solve this problem, but none had sufficient impact.

This is a problem that can be expected in future ISD projects. It should be realized that lesson specification production has a large manpower requirement. To avoid this problem the requirement should be over-estimated rather than under-estimated. The personnel to be involved in this phase should be clearly identified as early as possible. If at all possible, these people should be dedicated full-time to the effort. If part-time personnel must be used, then the manpower requirement should be expected to be larger. For example, eight half-time SME cannot produce nearly as many lesson specifications as four full-time SME. The ratio is nearer to--1 full-time SME = 3.5 1/2 time SME.

SME Turnover. As production of lesson specifications progressed, some SME were assigned to other activities, and new SME were assigned to the production of lesson specifications. As would be expected, this resulted in a training requirement for the new personnel. Once the new SME were trained, it took a while before they were up to their full production capacity. The net effect of these personnel turnovers was that overall lesson specification production was slowed.

This problem should be expected in future ISD projects. If at all possible, personnel should be assigned to the project who can continue until it is completed. If this is not possible,

then an increased number of SME should be assigned to offset the time lost during SME turnover.

Lack Of Lesson Specification Definition. Once lesson specification production began, it was found that the contents and format of the instance specification section (see Appendix G for more details) of the lesson specification had to be altered slightly. This was required to make the authoring of this section less complicated and subjective. These changes were incorporated into the lesson specification formatting guide. The changes had little initial impact on the production rates since the changes affected specifications for classification and rule-using objectives and authors, at the time, were preparing specifications mainly for recall level objectives only.

Eventually the changes made to the instance specifications proved to indeed simplify their production. Therefore, if this revised format is used it is not expected that this will be a problem in future ISD projects.

Non-operational Weapons System. Because the EA-6B (ICAP) aircraft is not yet fleet operational, it was difficult to get the detailed information required for production of clear, accurate lesson specifications. In areas where the ICAP aircraft was similar to the XCAP or standard version of the EA-6B, this problem was not significant. However, in areas which were not common to the other two versions, the SME had to spend a great deal of time researching engineering documents, and talking to the hardware technical representatives to find the required information.

Future ISD projects which deal with weapons systems which have not been implemented into the fleet are likely to suffer from this problem. One way to alleviate this problem would be to have all SME as involved as possible with the initial design, development, and testing of the weapons system. The more first-hand experience they have with the actual operation of the system the better. Whether or not this action occurs, the amount of man-power budgeted for this phase of work should be increased to insure adequate time for this systems operation research.

ADJUSTMENTS TO THE ORIGINAL PLAN

There were relatively few significant "adjustments" to the original plan in terms of ISD methodology--at least in the sense of altering basic procedures.

A number of new or modified procedures were used in this project, but they were planned for at the outset. These are summarized in the Detailed Technical Approach part of this section of the report. Several new data formats were developed

for the project which increased efficiency, but did not change methodology. An example of this was the Instructional Objectives Recording Form (Figure 13).

There were three areas in which methodology was modified to some degree during the project. First, the objectives hierarchy analysis procedure was significantly refined by the addition of four procedures--pruning, summarization, behavior approximation, and standard hierarchy structures. Pruning increases the utility of the hierarchy by deleting trivial objectives. Summarization increases the effectiveness of the hierarchy in prescribing necessary instruction. It does this by providing a reminder that procedural tasks with many steps must be taught along with an objective that insures that these steps will be remembered. Behavior approximation increases the precision of the hierarchies by providing for maximum fidelity of training for excessively dangerous or costly performance objectives. Standard hierarchy structures increase the speed and efficiency of the hierarchy analysis by providing a set of models which guide and prompt the analysis. The systems introduction hierarchy structure was particularly useful because it identified a frequently recurring set of relevant objectives.

The second area modified was media selection. The model originally intended for use in media selection on the EA-6B project was modified substantially in detail, although not in concept. Primarily, the basis for selection was extended to incorporate instructional content variables and degree of memory load inherent in each objective being analyzed. The computerization of the media selection process was also an innovation on this project, although it was strictly a convenience measure.

Finally, the lesson specification format was significantly modified during this project. From a one-page topic outline it was extended to a very detailed prescriptive, multi-page format. The Lesson Specification Guide used by SME was heavily illustrated. As a result it was much easier to use because it was less ambiguous. Although this was more a change of format than of concept, it was nonetheless significant.

SECTION IV

RESOURCES

This section presents an account of the resources used during the EA-6B (ICAP) ISD project. There are separate categories for personnel, time, facilities and equipment, and miscellaneous resources. The purpose of this section is to display the type of data being sought by NAVTRAEQUIPCEN as part of the effort to establish the resource requirements of ISD. The EA-6B project represents a sample of one. It was conducted under a unique set of circumstances, using a unique ISD model, by a unique group of contractor and user personnel, and only covered limited portions of the total process. Nevertheless, this data, when added to, or interpreted in the light of other similar data may well begin to establish a reliable basis for planning in future ISD applications.

PERSONNEL

Personnel hours expended on the project by the principal contributors are shown in Table 12. Hours are broken down by personnel category and major ISD task.

TABLE 12. ON-SITE PERSONNEL HOURS SPENT ON ALL ISD STEPS

ISD STEP	IP	IT	SME	
			Contractor	Navy
Job Analysis	212	100	133	247
Selection of Task	4	0	0	0
Hierarchy Analysis	136	365	235	208
Sequencing and Grouping	115	258	289	97
Media Selection	152	0	0	0
Lesson Specification	459	752	607	995
TOTAL HOURS	1,078	1,475	1,264	1,547

It must be emphasized that these data reflect actual time spent on task only. Time logs were very meticulously kept. Hours or portions of hours not devoted one-hundred percent to task activities were not recorded.

More detailed breakdown of hours by specific tasks within each major step are presented in the step-by-step project activities part of the Implementation section.

Total on-site personnel hours are shown in Table 13. These include all project-related hours, and incorporate the ISD task-specific hours shown in Table 12.

TABLE 13. TOTAL PROJECT-RELATED HOURS SPENT BY ON-SITE CONTRACTOR PERSONNEL

STAFF	HOURS
Instructional Psychologist	1169
Instructional Technologist	1656
Subject-Matter Expert	1636
Secretarial	1632

Total hours of off-site personnel are shown in Table 14. These are divided into professional, management, technical, and support categories. Professional hours include consulting, assistance with training and document preparation and technical monitoring. Management hours include contract management, organization of contract deliverables, and management monitoring of the project. Technical hours primarily include graphics support of contract deliverable products. Support hours include typing, composing, and secretarial assistance to contract and project management.

TABLE 14. TOTAL PROJECT-RELATED HOURS SPENT BY OFF-SITE CONTRACTOR PERSONNEL

PERSONNEL CATEGORY	TOTAL HOURS
Professional	1151
Management	523
Technical	454
Support	1239

From the standpoint of original expectations, there were two significant deviations in personnel hours spent on ISD tasks. The first of these relates to the course organization and sequencing steps; in particular, the development of lesson and unit maps. This specific task took 56 hours of IP, 189 hours of IT, and 229 hours of SME, which was well beyond initial expectations. Although the initial organization and sequencing of lessons from objectives hierarchies was completed swiftly, these decisions had to be reviewed and converted to graphic displays of lesson organization. During review a great deal of time was spent in making lessons more efficient and independent by reducing overlap or redundancy between similar objectives in different lessons. Also, the non hierarchy-related sequencing preferences described earlier came into play, and necessitated extensive revision to the syllabus.

It must be concluded that there is substantially more design effort involved in converting hierarchies to lessons than was originally thought. In the present project this additional effort was essentially unguided because it was not foreseen. Clearly, the ISD model is in need of extension and elaboration in this area to avoid the same problem in future applications.

The second major deviation from expected personnel times was in the lesson specification area. It was anticipated that between 2 and 3 segment specifications a day could be produced by SME. The contractor-provided SME, in fact, attained this rate. His average hours spent per segment was 3.0. However, Navy-provided SME took an average of 9.05 hours per segment, almost exactly three times as long.

The deviation in this group is attributable to two factors. First, the employment of Navy SME on a part-time basis, with frequent changes of assignment, vastly decreased efficiency in terms of extending the learning curve for writing lesson specifications. Second, the absence of readily available, hard information on the technical aspects of the ICAP system required the expenditure of great amounts of research time on the part of these SME.

It is clear that lesson specification requires either dedicated personnel or a superabundance of part-time, short termers. It is equally clear that in planning ISD projects for emerging weapons systems, provision should be made for increasing SME time during lesson specification, or for acquiring SME who have had experience with the research and development of the system.

TIME

The elapsed time for each ISD step was given in the Step-by-Step Project Activities part of the Implementation section.

A summary of projected and actual elapsed time for each ISD step is shown in Figure 17. This figure displays both the actual elapsed time of each step, and the phasing schedule modifications made at the end of each quarter.

It can be seen that the early activities took about the same amount of time as originally planned. However, some of the later activities took longer. For example, preparation of the Training Support Requirements Analysis took almost two months instead of the projected one month. Preparation of lesson maps took about two months, where no time at all had been allowed. Lesson specification also took considerably longer than planned.

Figure 17 shows that a number of steps were rescheduled, and actually began sooner than originally planned. These included hierarchy development, media selection and sequencing, training support requirements analysis, and lesson specification.

The explanations for these deviations are essentially the same ones given for personnel time deviations in the previous section.

The mis-estimate of training support requirements analysis time was due primarily to the newness of the procedures involved and the lack of coordination previously described.

FACILITIES AND EQUIPMENT

The equipment and facility requirements for this project were relatively small with respect to on-site activities. Navy personnel on the project were not re-arranged or re-located, and continued to occupy their individual work spaces.

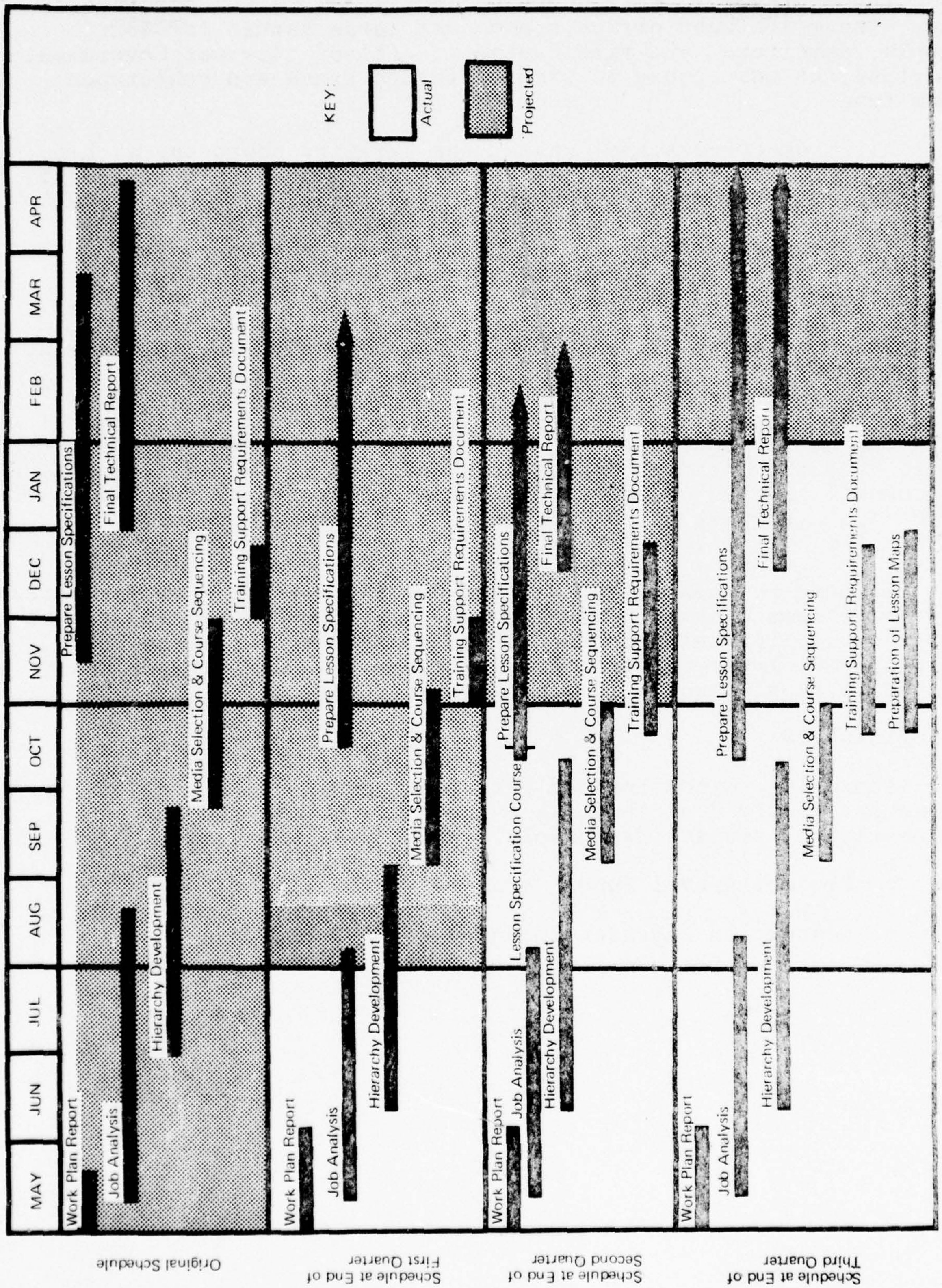

Figure 17. Actual and Projected Progress on the EA-6B ISD Project

The contractor staff occupied facilities in the same building. These included office space just large enough for four people, furniture, and file cabinets. All of this was Government-provided, as was access to secure storage space and conference room space.

All project personnel shared the existing photocopy machine in the VAQ-129 facility. This was a barely adequate arrangement which negatively impacted the project on occasion.

The contractor used the computer facility of a nearby university during the media selection process. This was paid for out of project funds.

The contractor provided all consumable supplies, telephones, and a typewriter.

Other types of facilities and equipment were provided or paid for by the contractor in connection with off-site project work. For the most part these included graphics supplies and equipment, and the production equipment and services related to printing. The cost of using these off-site facilities was $3,546.47.

It must be emphasized that Phase I ISD activities represented the least demanding of equipment and facilities of all ISD activities. A similar analysis for any of the subsequent steps (e.g., development, implementation) would have revealed a significantly higher level of resource demand in this category.

MISCELLANEOUS

The only project-related resources required, in addition to those previously described, were funds for travel and for relocation of project personnel to Whidbey Island area.

- Project travel funds amounted to $15,756.
- Relocation expenses amounted to $ 3,392.53.

SECTION V

CONCLUSIONS/RECOMMENDATIONS

Conclusions and recommendations will be presented under four different headings:

- The Basic ISD Model
- ISD Implementation
- Resource Requirements
- Speculative Observations

THE BASIC ISD MODEL

For the most part, the basic ISD model used in this project worked well. It was understood by SME and was practically workable. There seems little doubt that most of the specific techniques within the model are sufficiently well detailed to be used in a relatively standardized way across different projects. From this standpoint, the first two NAVTRAEQUIPCEN goals were generally well accomplished.

At the same time, the system was not flawless. Different techniques achieved variable success. For example, the task listing technique performed exceptionally well, and requires no systematic change. On the other hand, the procedures for determining goals, assets, and constraints were relatively undefined. Insufficient information on media constraints was obtained during job analysis, which delayed work during media selection. It seems clear that more robust techniques are required in this area. These should specify in greater detail the data to be acquired and the sources. More systematic provision should be made for an early review of the existing training system so that sequencing rules and customs--not derivable through pure ISD analysis--would not come as a surprise during course sequencing, as occured in this project.

The selection of tasks step turned out to be an almost trivial effort. A survey of other aircrew training ISD projects (SH-2F (LAMPS) and P-3) revealed similar findings. The basic idea is valuable and the technique is workable, but there seems little reason to retain it as an independent step in ISD. It is recommended that it be subsumed under Job Analysis. In fact, considering the emerging importance of analyzing goals, assets, constraints, and the existing course syllabus, it seems reasonable to propose that the entire Job Analysis step be re-named Problem Analysis or, simply, Analysis.

The objectives hierarchy analysis worked well. The model appears basically sound and the innovations introduced during this project enhanced the technique in a number of significant ways. These improvements should be incorporated into the basic model used on a formal basis.

Course organization and sequencing, media selection, and training support requirements analysis will be discussed jointly. As it turned out, these procedures worked, but not as efficiently as they should. Symptomatic of this inefficiency was the extended time required for both lesson maps (which is really part of lesson organization) and training support requirements analysis. Although it was recognized at the outset that media selection and sequencing were highly interdependent, and that both should be closely related to the logistical support system, insufficient provision was made for these interdependencies. What is required is a re-working of the basic model to provide what is lacking. In particular the procedures for course organization and media selection and the resource availability level of the particular project have to be made more consistent and closely related. The course must be organized to facilitate learning, administration, and sequencing. Media must also be selected so as to facilitate learning. But both must be responsive to resource limitations. The ISD model must provide a more comprehensive system for bringing about this set of conditions more efficiently.

The lesson specification procedure turned out a good product. Given a situation in which Phase II was not initiated and a training program had to be rapidly developed using traditional methods and existing media, the lesson specifications would prove extremely valuable as a basic design tool for any medium. The lesson specification is the only procedure that forces the development of training materials to carry through with the systematic analysis and design processes already begun in ISD. Without it, nothing bridges the gap between objectives and materials, and the developer is left free to pursue his own theory or instruction.

Given this line of reasoning and the fact that good, useable products were turned out, no changes to the basic ISD model are recommended for lesson specification. However, implementation modifications may be indicated, as discussed in the next section.

ISD IMPLEMENTATION CONSIDERATIONS

A number of recommendations for revising the method of implementing ISD were presented in the body of this report. These will be summarized now.

The job analysis survey is a valuable tool in validating the task listing and providing information for task selection. However, its administration proved cumbersome. It is recommended

that the survey be conducted on a smaller sample, using interview techniques. Consideration should be given to having SME conduct these interviews with their fellow professionals in the operational squadrons.

Further, it is strongly recommended that processing of survey data be computerized. It should be very simple to arrange the survey for response on an optical scan answer sheet, and to develop the necessary programming for data collation and display.

A basic assumption of the ISD model used concerned the difference between instructional process and instructional content, and how this difference defined the roles of the instructional designer and the SME. Implicit here is the further assumption that training squadron SME are, in fact, knowledgeable in the content. For an emerging weapons system such as EA-6B this assumption may not hold. Content-based problems were observable in both hierarchy analysis and lesson specification.

Three recommendations for minimizing this problem were offered earlier in this report. One was to begin the ISD process sooner to allow time for content research, while another was to assign more SME to compensate for slower progress. Both of these recommendations represent a frontal assault on the problem, and because of this may not be feasible. One problem with starting earlier is that the content is likely to be less and less firm the further back in time one goes in weapons system development. The problem may, in fact, get worse. Additional SME would solve the problem, but the improbability of this occuring in the real world of Naval Air Training makes relying on it a chancy matter.

The third recommendation was to have ISD project SME work closely with the hardware manufacturer or the R&D process to insure the acquisition and efficient transfer of vital information. This approach seems ideal, but its practicality is difficult to evaluate.

Beyond these three recommendations, other possibilities present themselves. However, their introduction will be reserved for the discussion on Speculative Observations later in this section.

A related implementation issue on this project was the level of SME support provided by the Navy. At several points in the project, lack of SME support impeded progress. This was particularly noticeable during lesson specification.

A direct approach to this problem is to call for a commitment of dedicated SME at the outset of any ISD project. However,

this is viewed as not likely to occur without some basic change in training squadron organization. Experience on other projects has shown that when an official, adequately staffed training squadron ISD team is created and given leadership of an ISD project, SME support problems are significantly minimized. Where this option is practical, its adoption is strongly recommended.

It should be recognized that the discussion above is predicated on the "independent ISD contractor" model, in which the contractor provides only ISD expertise. It is also predicated on the assumption that Navy SME are potentially the best SME. Both of these ideas have considerable merit. The ISD specialist contractor probably offers the best chance for bringing high-powered instructional process expertise to a project. Instructional development is his profession, and his experience is concentrated therein. Similarly, the Navy SME--a third tour aircrewman, for example--brings a wealth of operator-oriented (rather than gear-oriented) experience to an ISD project.

The question, however, is a practical one--can such an approach be supported with sufficient people? There are certainly compromise positions, such as having the ISD contractor provide the SME. And there are fall-back positions, such as relying on a hardware prime to supply both technical and instructional expertise. The desirability of these alternatives is partly a function of other issues. These will come up in Speculative Observations discussion.

There is one other general recommendation concerning ISD implementation that can be made. The recommendation is that computers be used to facilitate the ISD process. Specifically, results of this project indicate that computer programs could be used for processing the job analysis survey data, for first level media selections, and for estimating the development, implementation, and revision resources required for alternate media plans. These applications are strictly in the realm of data crunching. There is still the whole area of computer-based interactive aids for instructional designers and developers to be explored. Almost no development work has been done in this specific area, although it is quite feasible and highly desirable.

ISD RESOURCE REQUIREMENTS

The main resource used in this Phase I project was labor. This labor was expended on ISD system design activities, SME training activities, and actual ISD implementation activities. The question arises as to the representativeness of the labor data for application to future projects--is all of it needed, can it be minimized by more efficient procedures?

It is concluded that the hours expended on this project were reasonable, given the activities that had to be performed. It is also concluded that some of these activities are non-recurring, and that others can be streamlined, with the net result of a significant savings in personnel hours.

Non-recurring activities were mainly those involving ISD system design and SME training program design. A substantial portion of the contractor's off-site staff hours was spent in these categories. The final set of ISD procedures used on this project reflect this design input, indicating that it would not be required in future projects if the same model were used.

The ability to streamline ISD implementation is directly related to implementing the recommendations made in the previous two sections. If the model and the implementation procedures are revised as suggested, significant cut-backs in personnel can be accomplished in certain areas (job analysis survey, organization and sequencing, media selection, training support requirements analysis).

The personnel time data gathered on job analysis and hierarchy analysis appears to be the most stable and reliable. Lesson specification data is also viewed as fairly reliable if one pays attention to the differential work rates observed in Navy-provided and contractor-provided SME. The contractor SME work rate is judged to be quite stable. The Navy SME work rate is, however, likely to vary as a function of training squadron personnel policy regarding how ISD is supported. The work rate observed on this project can be substantially improved under the type of organization recommended in the previous section.

Personnel time requirements for media selection, sequencing, and training support requirements analysis are regarded as less reliable from the standpoint of predicting needs on future projects. As pointed out earlier, there is room for streamlining these procedures, but it is difficult to estimate how much efficiency can be gained.

The following is an attempt to establish guidelines for estimating ISD personnel requirements. The assumptions which govern these estimates are:

- Training is oriented to aircrew members.
- The weapons system is partly an evolving one.
- The training program to be developed is for a significant crew position (one that normally takes 5-6 months to train for).

- Phase II ISD will be performed by a different contractor-SME team.

- ISD expertise is provided by an outside contractor who places a project staff on-site.

The number of personnel hours required for Phase I ISD activities for one crew position are shown in Table 15. Required hours are estimated for implementing ISD as it was on the EA-6B project, and for implementing it after recommended modifications to procedures have been made.

Several points about this table should be noted. First, SME hours are given for either contractor SME only or Navy SME only. A mix of the two could be accomplished by equating one contractor SME hour to two Navy SME hours.

Some ISD tasks show little or no potential for improved efficiency. These are the tasks which worked well on the EA-6B project, and for which no significant recommendations were made. In contrast, the organization and sequencing step shows a very large potential gain in efficiency, assuming recommended modifications in lesson map procedures are carried out.

It should be noted that media selection and training support requirements analysis hours would not increase noticeably were two or more crew positions involved *in training development*. This is because both procedures are essentially independent of the number of objectives to be taught. All of the other steps, however, are linked to amount of instruction in a direct, more or less linear fashion.

The lesson specification procedure used on the EA-6B project was based on the assumption that different individuals would carry out Phase II, when it came about. This led to the employment of a very robust specification model. However, a less stringent specification can be used on projects where ISD tasks are continuous and are performed by a stable group. Under these circumstances, it is estimated that a 40% savings in SME hours can be effected.

It must be emphasized that other categories of personnel are required. Quality control monitors at the professional level are required to insure adherence to process and product specifications. Technical and support personnel are required to handle the documentation and reporting load that is required on ISD projects. However, these hours are relatively small compared to those of the main contributors shown in the Table.

TABLE 15. ESTIMATES OF REQUIRED PERSONNEL HOURS FOR PHASE I-TYPE ISD ACTIVITIES ON ONE CREW POSITION

ISD TASK	PERSONNEL HOURS							
	IP		IT		CONTRACTOR SME ONLY		NAVY SME ONLY	
	EA-6B Model	Improved Model	EA-6B Model	Improved Model	EA-6B Model	Improved Model	EA-6B Model	Improved Model
Job Analysis	81	73	46	42	178	178	256	256
Hierarchy Analysis	68	68	183	183	170	170	339	339
Organization & Sequencing	58	43	129	100	242	85	337	169
Media Selection	30	30	0	0	0	0	0	0
Training Support Requirements Analysis	112	80	0	0	0	0	0	0
Lesson Specification	203	203	406	406	1779	1779	5337	3558

SPECULATIVE OBSERVATIONS

There is no question that a great deal was accomplished in the EA-6B (ICAP) ISD project. A detailed, full-scope, prescriptive ISD model was shown to be practical and workable. It resulted in good, useable products, and it generated valuable data about ISD costs and resource requirements. In this sense, project goals were successfully accomplished, for the most part.

In spite of this, there is a strong, lingering impression that all is not right with ISD. The detailed processes of task listing, objectives analysis, media selection and so forth appear to be well in hand--reasonably standardized and exportable. The trouble seems to be where these procedures touch the real outside training world. How to create a facilitative instructional sequence is known. But how to integrate this sequence with squadron customs and preferences for sequencing is not known. Matching media to learning requirements is easily done. Determining what kinds of media will be available and in what quantities is not. These examples, which occurred in the EA-6B project, are symptomatic of the general problem, which seems to be one of trying to apply a sophisticated training development system to a training environment that isn't ready for it.

For instance, ISD makes a very worthwhile distinction between content and process experts. The problem is, the Naval Air Training Community doesn't have any process experts. If they must be procured from outside, what rules govern the procurement? Furthermore, the Navy does not really even have subject-matter experts, at least available in the concentration demanded by ISD. This was demonstrated in the present project. If they are to come from outside, should they be former crewmen or hardware and systems representatives?

Another serious aspect of this general problem was felt only mildly on the EA-6B project. The problem is developing training for an evolving or emerging weapons system. Existing ISD models are not much good as is because they assume a job exists that can be analyzed, and information exists that can be shaped into instruction. EA-6B had no trouble with task listing, but did have trouble getting the detailed information necessary for lesson specifications. The difficulty with waiting until all R&D work has been completed is that by that time the weapons system is almost ready for delivery, at which time actual training begins.

The other side of this same coin is the difficulty encountered by weapons system planners in determining the long-range resource demands of an ISD application. Some of the more elaborate aspects of ISD make it much more difficult to plan for than the more traditional system of purchasing "training" from the hardware or systems prime contractor.

There is a host of possible solutions to these problems, but making the right selection is a complicated task because of the number of variables involved and a lack of information about how ISD interacts with the existing training system.

As has been shown, some of the specific problems encountered on the EA-6B project are representative of the more general problem. In terms of solutions, it may turn out that the only available SME for evolving weapons system training development are those belonging to the prime contractor. If so, it may be possible to purchase the training program with the aircraft and insure high quality by levying a set of ISD-based specifications and data items. For existing weapons systems it may be best to use ISD contractor SME, or to increment the resources of the training squadron or of a Fleet Introduction Team and create a formal ISD team. Once again, these options are difficult to assess out of context. Unfortunately, the context itself is not too clear because of lack of information.

Clearly what is required is a study of the entire Naval Air Training system which outputs a comprehensive approach to implementing ISD in an integrated way. This need has already been perceived by NAVTRAEQUIPCEN, which is presently sponsoring just such a study.

Appendix A

A Systems Approach

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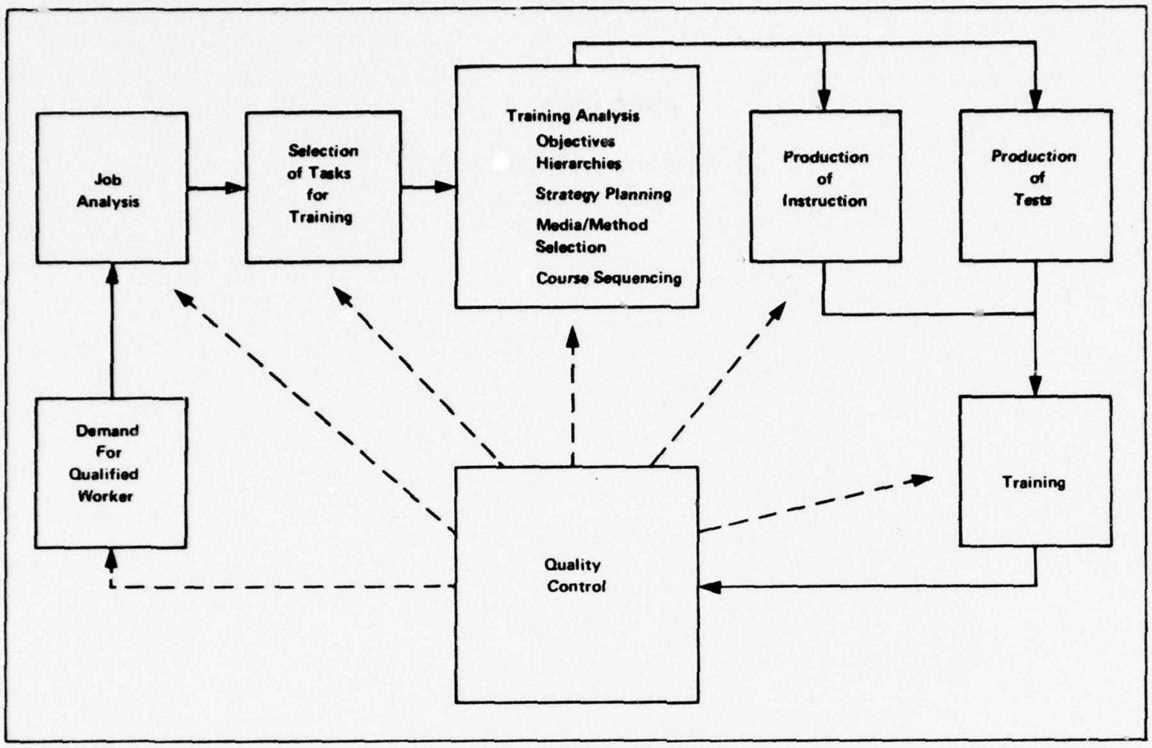


Systems engineering of training is a method of designing training courses which employs a series of orderly, logical, interrelated steps to produce a course which is efficient and effective in providing graduates with the skills, knowledge, and attitudes essential to the performance of a job. Instructional science has advanced to the point where instructional development need no longer be summarily an artistic exercise, but rather can be a systematic and methodical application of this science within the limits imposed by resource constraints.

There are many ways of describing the steps in a systematic instructional development process and many terms have been used to describe these steps and the activities associated with them. At its core, however, any systematic approach to instructional development has three phases: determining what must be taught, determining how to teach it, and determining whether or not the teaching has been successful. Almost everyone knows these steps are important and has diagrams or flowcharts naming the steps that must be taken. Far fewer people have specific, definable and teachable procedures or techniques for actually implementing a consistent, logical and practical systems approach to instructional development. The following pages outline a systems approach that has been developed and validated by Courseware, Inc. for solving training problems in a wide variety of applications.

UNDERLYING ASSUMPTIONS OF A SYSTEMS APPROACH

The following assumptions underlie Courseware's systems approach:

1. Human performance problems are frequently best solved by management action or situational modifications. Training programs should be established only when these more direct solutions are unavailable.

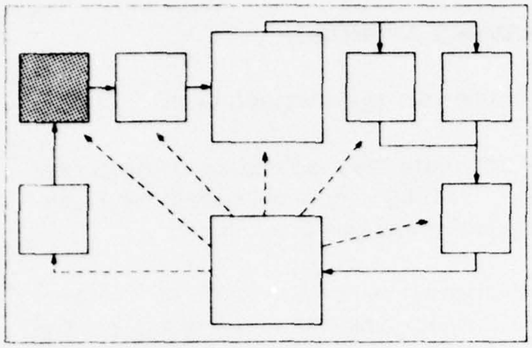
2. The content of an instructional program must be relevant to the performance requirements of the job, position or duty for which the course is preparing the students. The course should teach what is required on the job.

3. A good instructional program must be efficient in terms of accomplishing its goals with minimum consumption of instructional resources (time, money, people, facilities).

4. The most effective instructional programs are those which are predicated on some form of explicit learning outcomes or objectives.

5. The selection of any instructional method, medium, or device should be based on the kind of learning situation involved. The "goodness" of such methods cannot be spoken of in the abstract, but only in terms of some specific learning situation, or class of learning situations.

6. All instructional programs are something less than fully effective and fully efficient due to mistakes made by instructional designers, particularly during the early versions of the course. A good instructional design system must, therefore, provide for empirical testing of the instruction, followed by revision or modification in those areas of instruction that have been shown to be ineffective or irrelevant.



STEP 1:
JOB ANALYSIS
The process of breaking a job or function down into its component tasks by reading job literature, observing job performance, and questioning job holders and their supervisors.

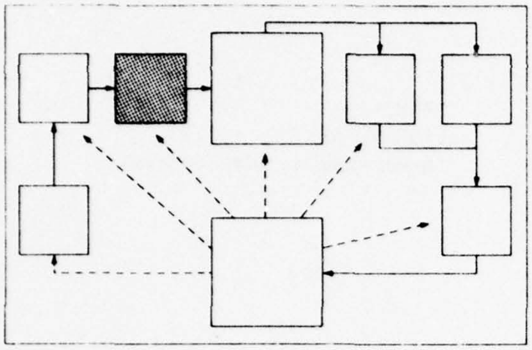
In accordance with the first assumption concerning course relevance, it is imperative to begin the instructional design process by a thorough analysis of the job. Only in this way can the performance requirements be determined. The tasks identified in the job analysis become the goals of the instructional program.

Some jobs are described in organizational publications. What goes on in a job can also be determined by on-site observation or by consulting with supervisors who have wide and lengthy experience with the job. Finally, questionnaires to current job-holders can reveal, in minute detail, what tasks are actually performed. The "Job Analysis Questionnaire" at the right illustrates a possible way of surveying job-holders.

The basic output of this first step, job analysis, is a detailed list of tasks performed on the job by relatively inexperienced personnel. Along with this, data are collected on supervision available on the job, constraints on task performance and other factors relating to job performance.

STEP 1:
JOB ANALYSIS
A job analysis questionnaire.

TASKS	How frequently do you perform this task?			How soon after training did you first have to perform it?			Where did you first learn how to perform it?			How closely are you supervised when performing this task?		
	Never	Some-times	Often	0-3 mos	3-6 mos	Over 6 mos	On Job	In Schl	Other	None	Spot	Close
1. Prepare strength reports												
2. Perform surgical airway												
3. Make red blood count												
4. Present training lectures												
5. Order supplies												
6. 7. Etc.												

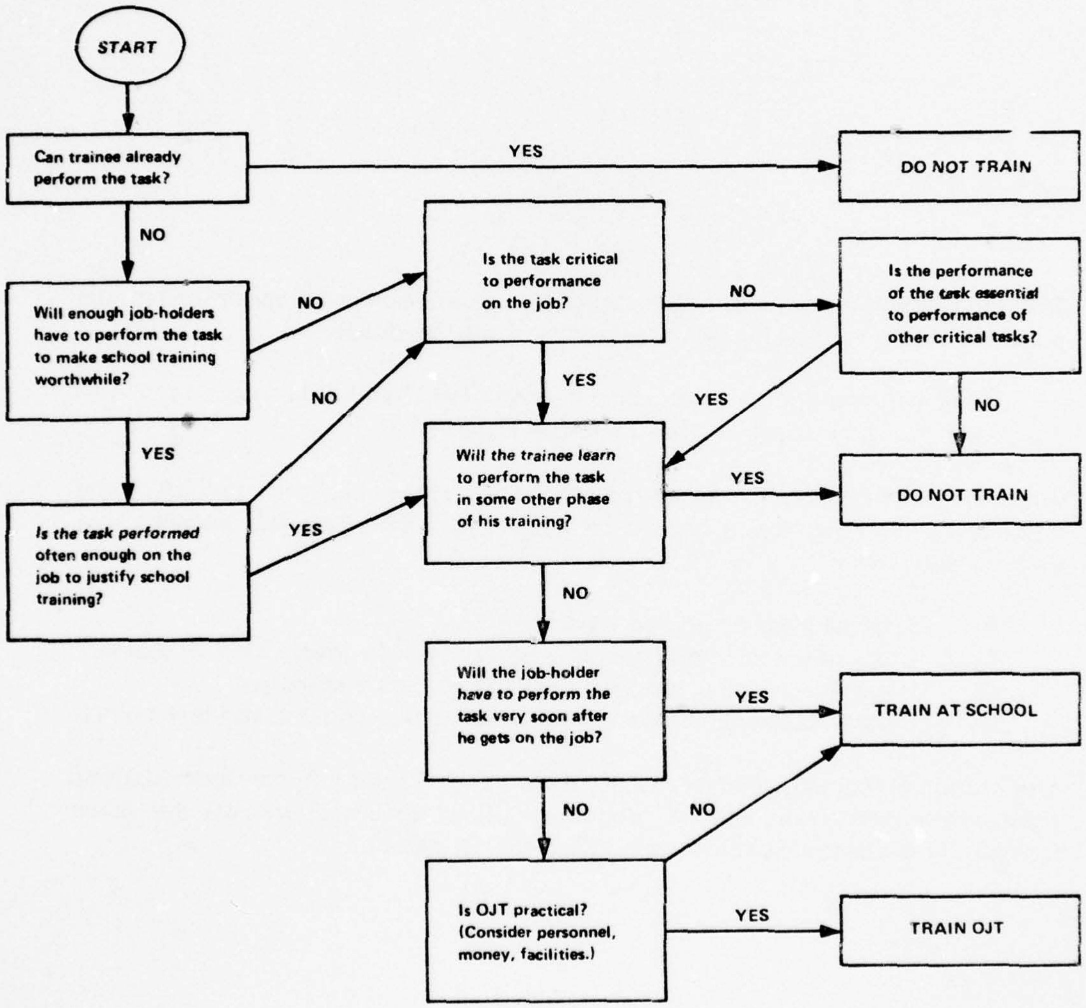


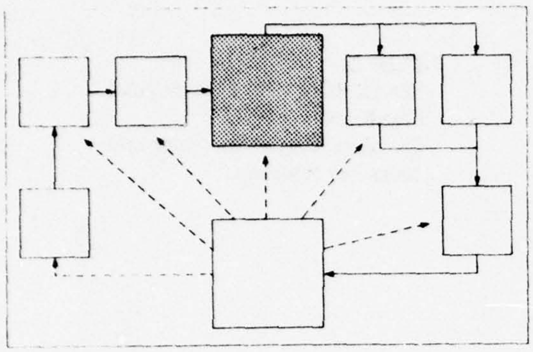
STEP 2:
SELECTION OF TASKS FOR TRAINING
The process of identifying, out of all of the tasks normally performed on a job, those that must be trained in the instructional program being designed.

Initial training programs should focus primarily on tasks that are frequently performed on the job, that will be immediately required in the first weeks and months on the job, and that are critical to minimum satisfactory job performance. The diagram on the facing page is a decision-aiding flowchart which may be applied to every task performed on the job. One of three decisions must be made about each task: train at school, train on the job, do not train. Tasks that can already be performed by students at entry into the course need not be taught. Tasks which the job analysis reveals to be both infrequently performed and non-critical also may be omitted from the training. Tasks that the graduate will not perform until he has achieved a certain amount of job experience are often best delayed for later courses, or inservice (on-the-job) training.

The output of Step 2 is a list of tasks or job performance requirements which must be trained in the course being developed.

STEP 2:
SELECTION OF TASKS FOR TRAINING
Decision model for selecting tasks for training.





STEP 3:
TRAINING ANALYSIS
The process of converting job requirements to a set of sequenced learning objectives with instructional methods and strategies specified for each.

Training analysis is the heart of the instructional development process. Up to this point instructional development has focused on the question,

> "What will the course graduate do on the job that we will have to teach him how to do in the training program?"

With that question answered, instructional design then shifts to consider what must be learned and how it should be taught. Training Analysis involves four distinct activities:

(A) Specification of course objectives
(B) Designation of method/media to be used to teach each objective
(C) Development of a teaching strategy for each objective
(D) Determination of course sequence to include practice and test points.

The output of training analysis is a detailed set of instructional specifications from which instruction will be produced. Then specifications are set down formally in a Lesson Specification. (See facing page.)

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A STUDY OF THE EFFECTIVENESS, FEASIBILITY, AND RESOURCE REQUIRE--ETC(U)
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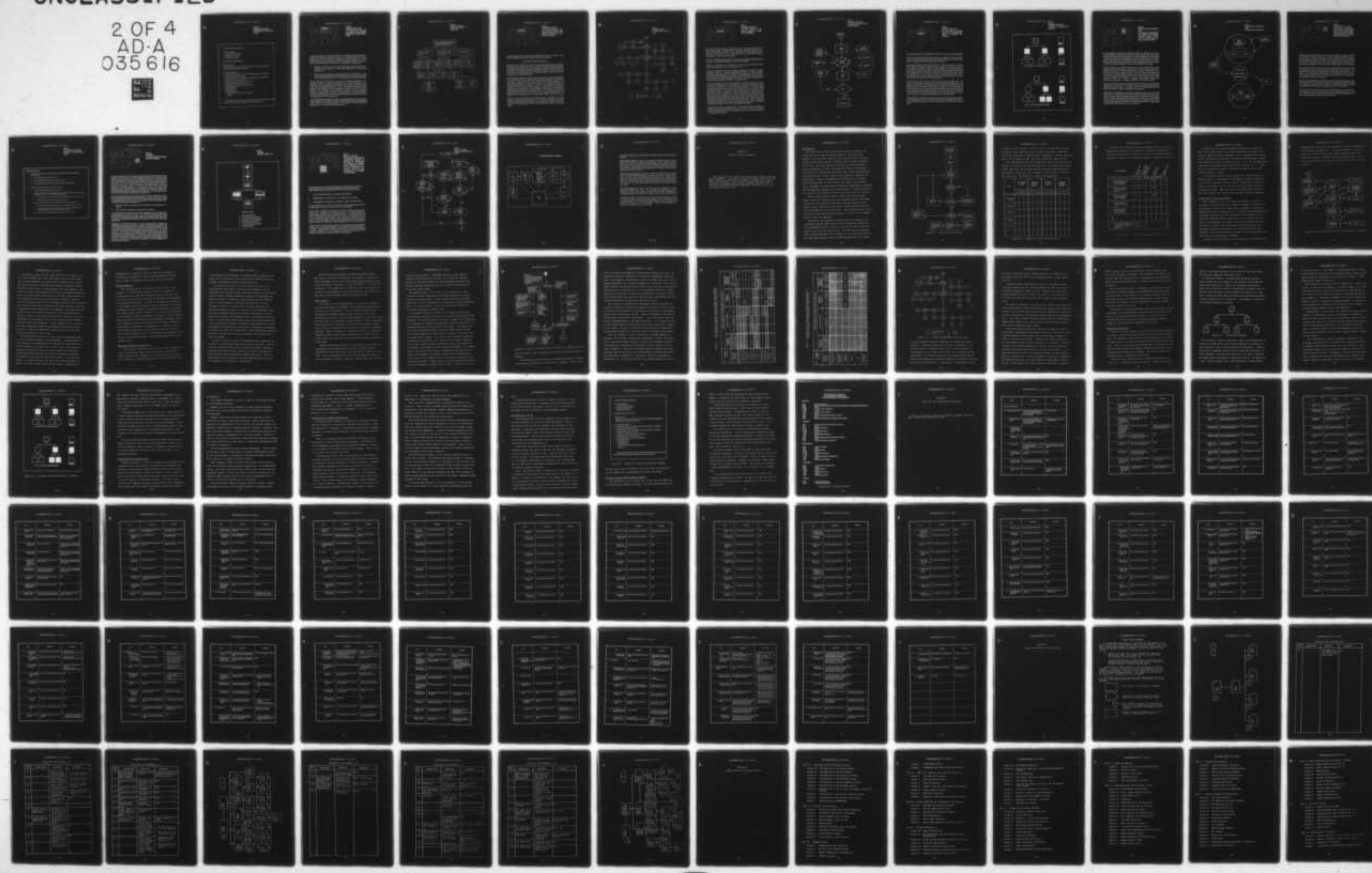


STEP 3:
TRAINING ANALYSIS
An outline for a Lesson Specification.

*1. Lesson Title, Number & Unit Reference

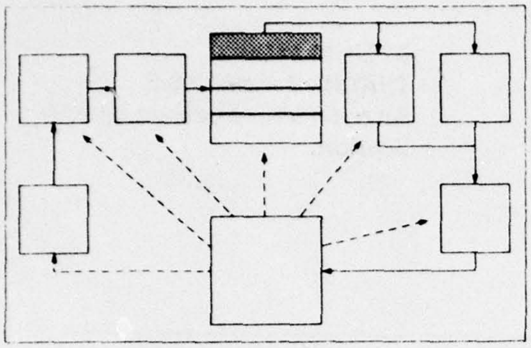
2. "So What" Statement
   a. Rationale (Importance) of lesson
   b. Relationship to other lessons
   c. Job-related aspects of lesson

3. Sequenced Lesson Objectives Hierarchy

4. Sequence of Events
   Specifications of unifying theories or ideas which integrate or coordinate lesson segments and help achieve smooth transition and student flow.

5. For each Objective (Segment)
   * a. Objective Type (memory, concept, rule, problem solving, familiarization, psychomotor)
   * b. Instructional Method/Media to be used
   * c. General Statement of what is to be learned (e.g. Concept definition or rule statement)
   * d. Sample set of instances (1 for each type)
   e. Algorithm for concept identification or rule, application
   * f. Example Specification (type, range, number)
   g. Special Teaching Points (critical content considerations)
   * h. Strategy Specifications
   i. Graphic Specifications
   * j. Testing Specifications
      (1) Need for and placement of tests and practice items.
      (2) Test type

*These items must be included in all lesson specification documents. Other items may be included at discretion of the subject matter expert (SME) or instructional psychologist (IP).



STEP 3:
TRAINING ANALYSIS
The first activity in the training analysis is the SPECIFICATION OF COURSE OBJECTIVES.

A learning objective or instructional objective is a statement describing what a student will be able to do following instruction, under what conditions he should be able to do it, and to what level of competence he should be able to do it. Such statements (objectives) are highly useful to the instructional designer, to the test writer, and to the student. They are the cornerstones of all instruction.

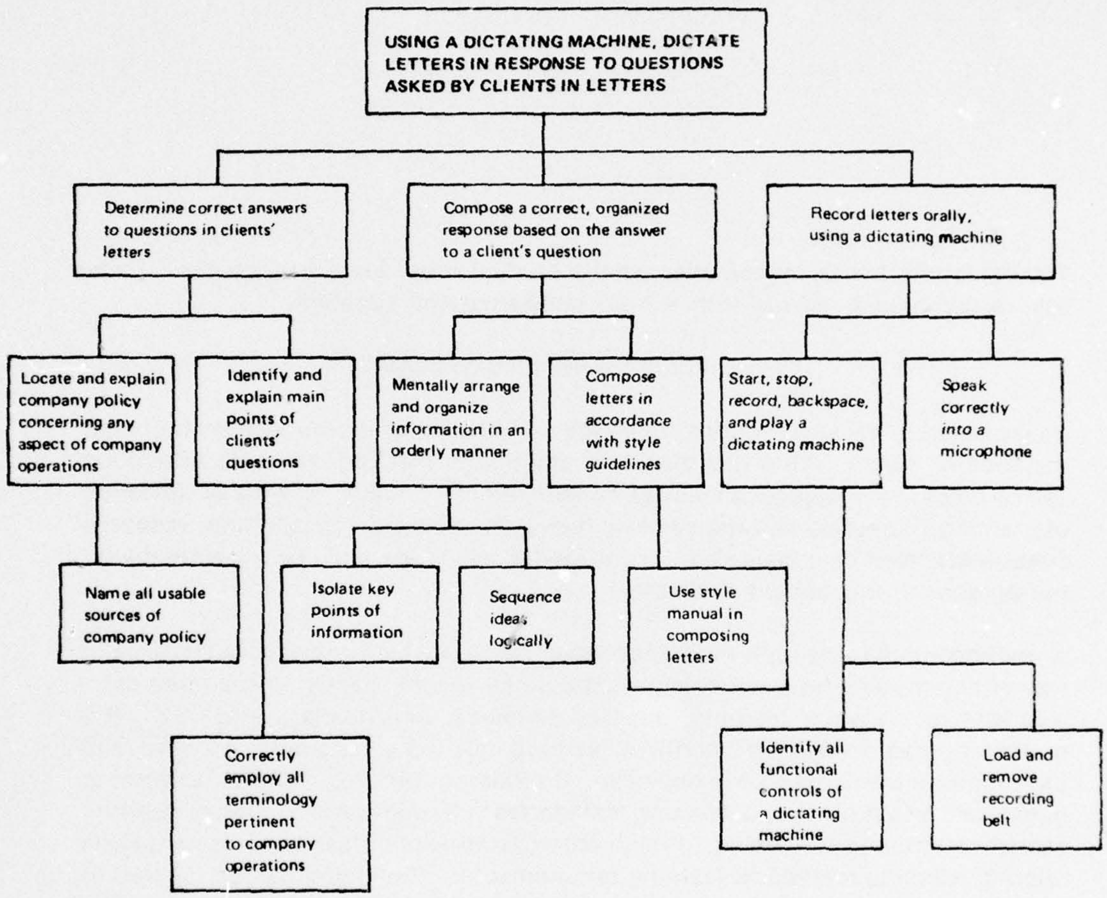
1. Derivation of terminal or end-of-course objectives is fairly simply accomplished by direct conversion of major task statements into instructional objective form.

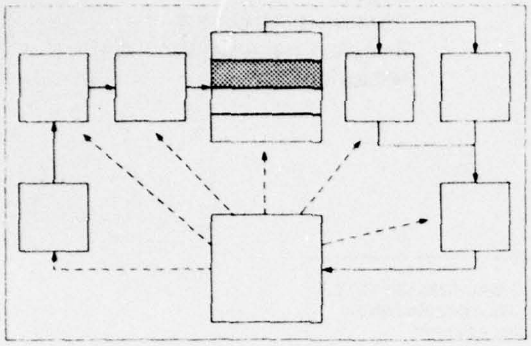
2. Derivation of intermediate or supporting objectives is more difficult. Supporting objectives represent the more basic skills, knowledges and attitudes that must be learned before the terminal objective can be accomplished.

Interim objectives are determined by constructing objectives hierarchies. An objectives hierarchy is a sequential breakdown of a terminal objective into its supporting skills, knowledges, and attitudes. Starting with the terminal objective at the top, the question is asked: "To be able to perform as specified in the objective, what essential skills, knowledges or attitudes must the individual possess?" This will yield a number of major components. For each component the question is asked again. The output of this procedure is a multi-level hierarchy in which the objectives at any one level are prerequisite and essential to performing the objectives at the next higher level.

A completed objectives hierarchy reveals all of the objectives that must be learned. It also specifies the coordinate and subordinate relationships and suggests the order in which they should be learned. The process of objectives hierarchy development is sometimes called task analysis.

STEP 3:
TRAINING ANALYSIS
Sample Task Analysis: dictating letters.





STEP 3:
TRAINING ANALYSIS
The second activity in the *training analysis* is METHOD/MEDIA SELECTION FOR EACH OBJECTIVE.

The objectives hierarchy specifies what a student must learn in a course. Once that is completed, efforts turn toward answering the question,

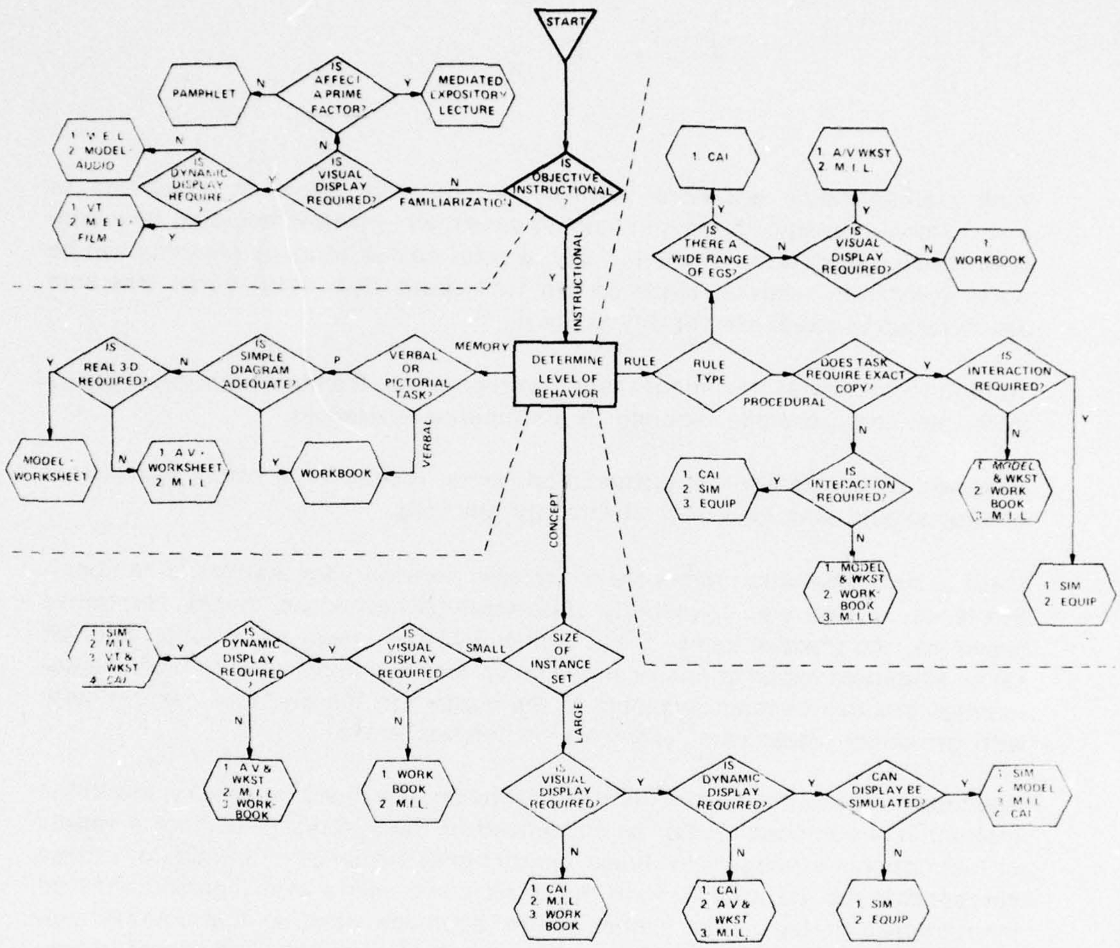
"How should the teaching be done?"

As indicated in the assumptions, there are no universally appropriate instructional methods or media. What this means in practice is that before media selections can be made, each objective must be considered individually in terms of the kinds of learning it involves and the sensory demands it makes. In addition, resource constraints must be considered, for the media selections must be consistent with the personnel and budget available.

A method/media selection model has been devised which provides a systematic way of determining how any objective should be taught, based on the three decisive factors: type of learning, sensory demands, and media availability. The model focuses largely on cognitive learning but also considers affective and psychomotor elements of any objective. It relies on the classification of learning outcomes into four broad learning categories: familiarization, memorization, classification, and rule using. It also employs an explicit series of assumptions relating teaching method to learning requirements. The model can be tailored to specific training situations and to specific method/media specifications. The adaptation of this model as used for one particular project is shown at the right.

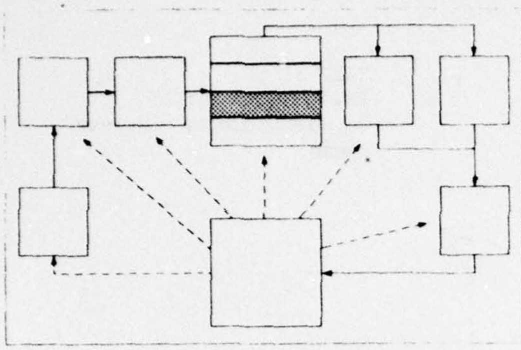
Often new instructional methods, or new applications or integrations of existing methods or media, can be developed in order to meet the demands of a particular situation. Detailed descriptions of these "new" methods and media must be developed prior to the development and use of the media selection model for a particular project.

STEP 3:
TRAINING ANALYSIS
A method/media selection model.



KEY

CAI	COMPUTER ASSISTED INSTRUCTION	VT	VIDEOTAPE
M.E.L.	MEDIATED EXPOSITORY LECTURE	WKST	WORKSHEET
M.I.L.	MEDIATED INTERACTIVE LECTURE	EQUIP	REAL EQUIPMENT
SIM	SIMULATOR	AV	AUDIO/VISUAL



STEP 3:
TRAINING ANALYSIS
The third activity in the training analysis is STRATEGY PLANNING.

With method/media decisions resolved, attention is turned to questions of instructional strategy. Strategy planning essentially involves deciding how content will be presented to students. But, a great deal of strategy planning can be done apart from content, since certain techniques and instructional elements are required to teach almost any content.

Traditional strategies (techniques) such as prompting, feedback, advanced organizers, etc., are generally required in instructional materials.

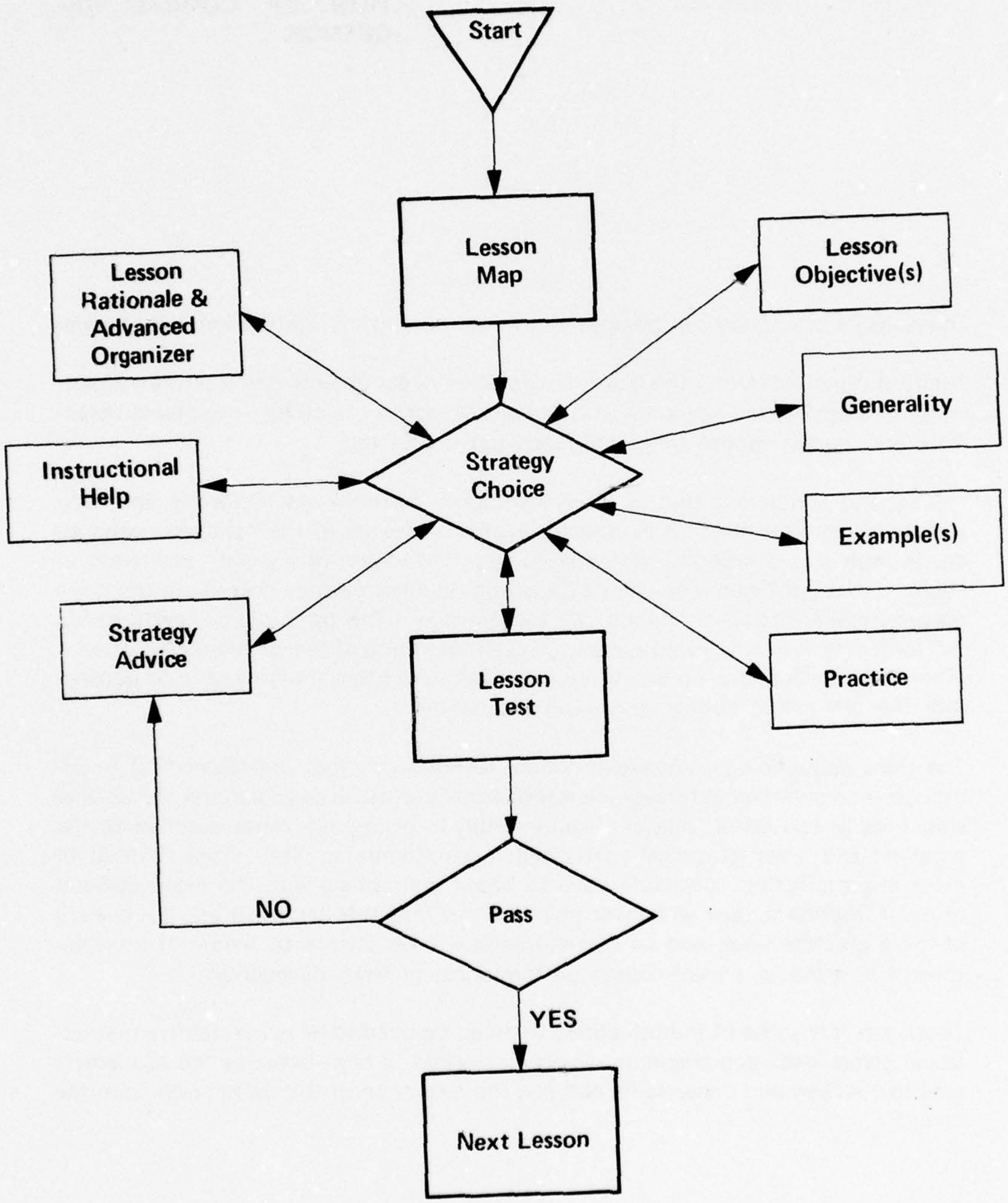
However, a consideration of presentation forms, instructional helps, and learner control should also be a part of strategy planning.

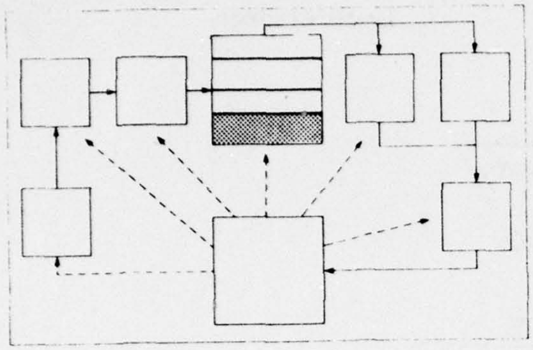
Three basic presentation forms are considered necessary for instruction in cognitive tasks. These are: generality statements (definitions or rules), illustrative examples, and practice items. Instructional helps represent an optional, but rich set of simplified explanations or mnemonics and highlighting of critical characteristics that can be made available to the student in the event he has difficulty with generality statements, examples or practice items.

The three presentation forms, instructional helps, advanced organizers, and other instructional components can be sequenced in many ways to achieve a variety of instructional strategies for linear instructional sequences. In addition, these components can be used to form the basic components of a learner-controlled instructional strategy. The learner control approach views an instructional program as a set of learning resources. These include generality statements, examples, practice items, feedback tests, instructional helps, advanced organizers, rationale for learning, lesson maps, objectives, lesson surveys and others. These resources are all made available to the learner and he is free to select the resources he needs to accomplish the objectives as he needs them. Thus, in a learner-controlled lesson, the student is free to determine his own highly individualized instructional strategy as he works toward defined objectives.

By carefully defining or specifying these instructional strategy components, a separation between instructional strategy and instructional content is achieved. This unique approach translates into a powerful tool for very efficient production of high quality instruction.

STEP 3:
TRAINING ANALYSIS
A Learner-Controlled Instructional Strategy.





STEP 3:
TRAINING ANALYSIS
***The last activity in training analysis is the* DETERMINATION OF COURSE SEQUENCE.**

Three major principles can be applied in determining the instructional sequence.

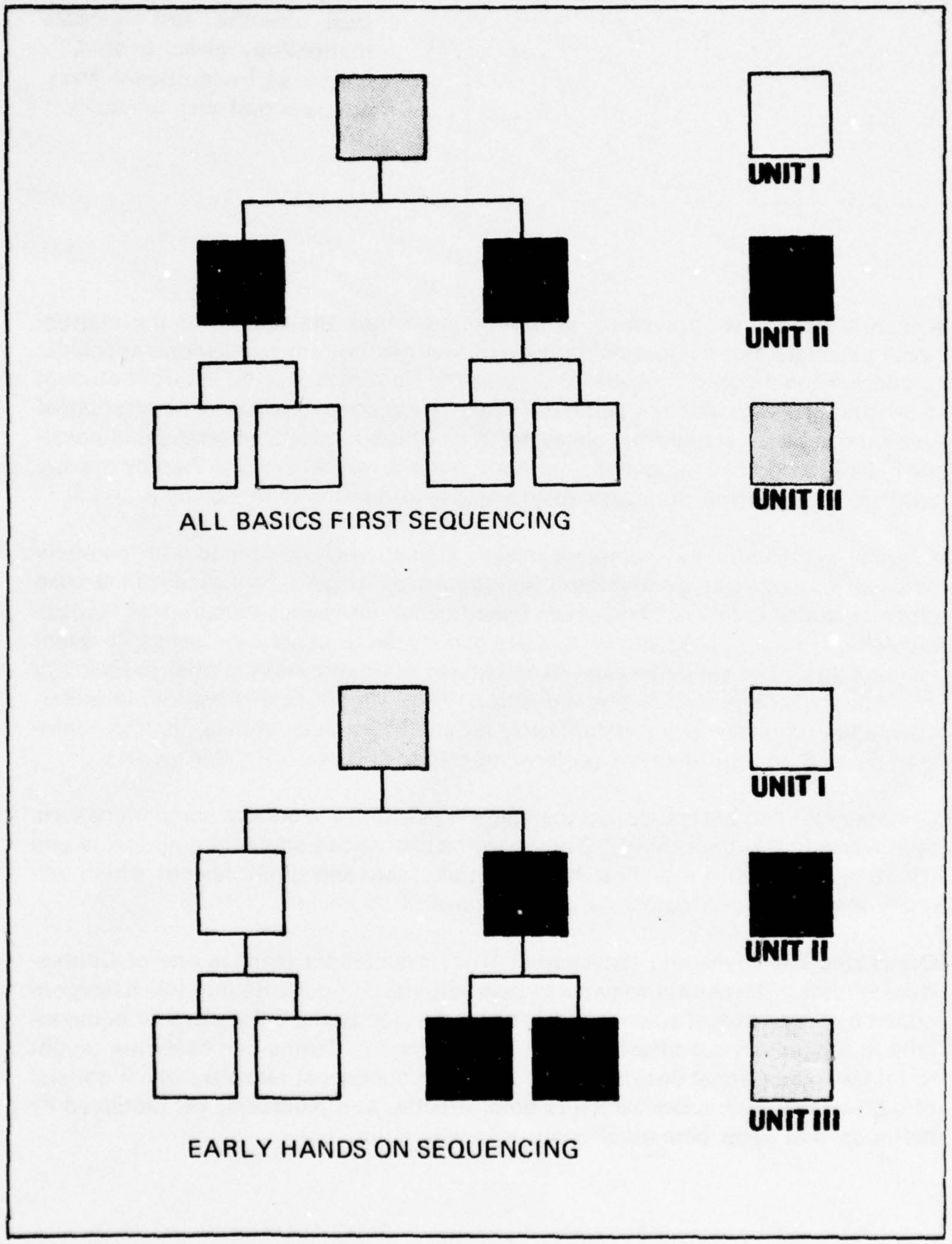
The first principle is that the hierarchy position of an objective is a primary determiner of instructional sequence. Within any objective hierarchy, lower level objectives are usually taught before higher level objectives.

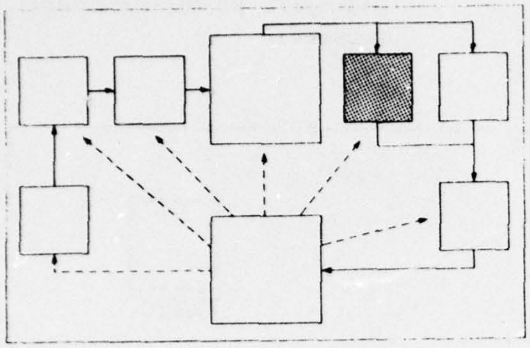
The second principle is that of "early hands on." Within any hierarchy, the decision to teach all bottom-level objectives, then move up to the next level, and so on, is logical and orderly. However, it keeps students in a purely academic or memorization-of-basic-tasks mode for a long time before they ever get to the more rewarding application or "hands on" experiences. The principle of "early hands on" indicates that it is often better to teach one vertical leg of hierarchy, then a second vertical leg, and so on. What this does is to bring the student into contact with the real world sooner and more frequently.

The third sequencing principle is "most difficult or most important first." Although it seems logical to sequence the terminal objectives to parallel the normal sequence of job tasks, this can easily result in giving the most practice to the simplest and least important performance requirements. The "most difficult or most important first" principle says to begin instruction with the most difficult or most important task whenever possible, so that this task will get the benefit of more practice time, and so that students will be constantly aware of the relevance (in terms of end-of-course performance) of their instruction.

These are only some of the principles that can be used to develop creative instructional sequences--sequences in which motivation is high because the student is able to succeed and because he can see the relevance of the instruction from the onset.

STEP 3:
TRAINING ANALYSIS
Examples of instructional sequence.





STEP 4:
PRODUCTION OF INSTRUCTION
The process of creating practical, effective, and palatable instruction, given a specification of instructional strategy, content and media.

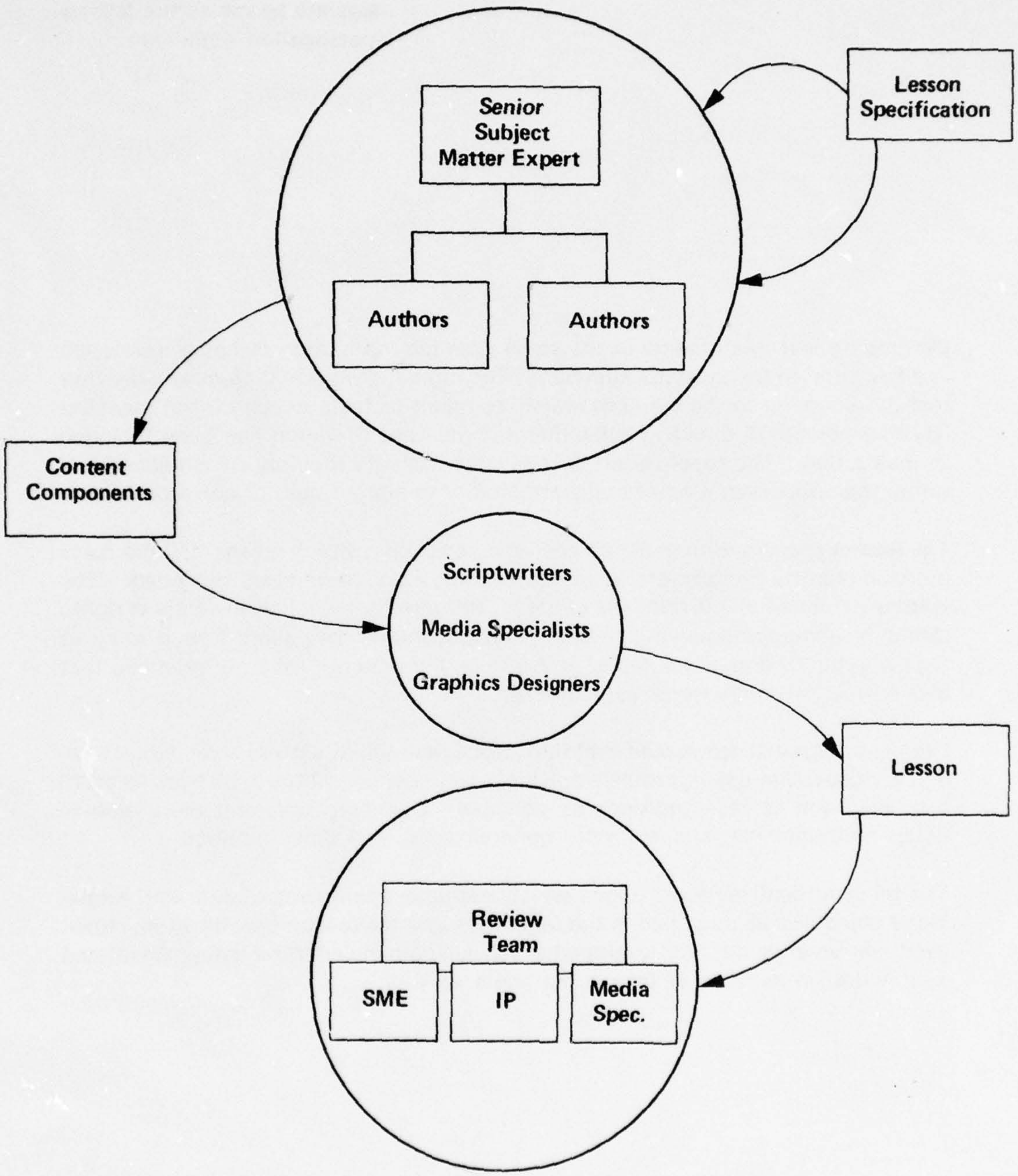
A team approach to production of instruction brings the talents of the instructional psychologist, subject matter expert, and media/communications specialist to bear on the difficult problem of getting the right message to the right student in an effective, efficient and palatable way. When considerations of instructional content can be separated from considerations of instructional strategy, it is possible to have different people make inputs in these areas separately, thereby making a differential staffing approach to instructional development possible.

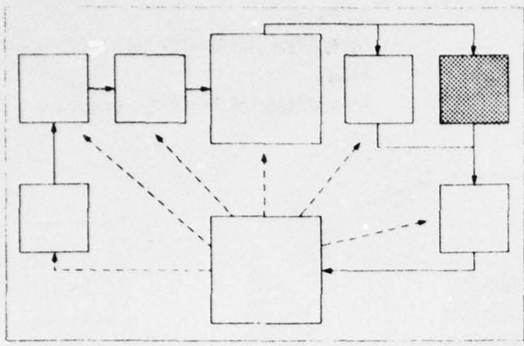
A highly systematic and complete design phase, when combined with carefully detailed instructional development handbooks or models, makes possible even greater division of labor. The Lesson Specification provides a blueprint for instruction which junior subject matter experts can follow to supply the needed content components. The subject matter experts need not learn instructional psychology or a new vocabulary to describe old ideas. They simply supply content in understandable "chunks" (i.e., definitions, examples, non-examples, practice problems), and arrange them in patterns specified in easy-to-follow models.

Once content has been supplied the stage is set for the media or communications specialists to "do their thing." They take the sequenced content components and weave in the creative storyline, humorous pictures, and other devices which will make the instruction easier to understand and appreciate.

Organizing and managing the instructional development team is one of Courseware's fortes. The careful analysis of instructional components that has been generated by instructional scientists and which has led to the definitions of components in the lesson specification pays big dividends. Teams can easily be taught to follow instructional design guides in the production of lessons, which consist of high-quality instruction which is both effective and palatable, yet produced by methods that keep personnel costs to a minimum.

STEP 4:
PRODUCTION OF INSTRUCTION
Instructional Team Interaction





STEP 5:
PRODUCTION OF TESTS
The process of creating tests which measure both student learning and course effectiveness are based on the lesson specification document.

Developing test instruments at the same time the instruction is being developed is a key point in the systems approach. The more conventional approach--leaving test development to the very end--tends to result in tests which do not measure learning objectives directly, but rather sample content which has been included in instruction. The result often is that tests evaluate memory of isolated facts rather than understanding of concepts, ability to apply rules, or solve problems.

The lesson specification includes sections on testing, which means that the tests are designed by the authors at the same time that lessons are designed. The lesson specification provides the guide for test development (see example at right). Using it, and accompanying format guides, content specialists find it easy to supply proper content for tests, and efficient production of truly effective test and evaluation instruments is achieved.

Lesson tests are developed so that they probe learning at a given level (e.g., memory, concept, rule-using, problem solving) and under conditions which are as much like actual job or use conditions as possible. Concepts and rules are evaluated using methods that ensure proper generalization and discrimination.

The most critical tests are those which evaluate attainment of skill and knowledge objectives as specified in the objectives and the lesson specification. However, instruments must be developed which evaluate the effective management and administrative aspects of lesson materials as well.

STEP 5:
PRODUCTION OF TESTS
Example of Testing Specification.

TESTING SPECIFICATION

I. The test for this lesson will include twenty (20) problems. The problems will involve the subtraction of one-digit fractions.

A. All of the problems will be of the form 1/4 - 1/8 = .

B. No whole numbers expressed as fractions (e.g., 8/8) will be used.

C. Problems will be developed such that all answers will be positive single-digit fractions.

II. The test will include some problems of each of the following types:

A. Problems with common denominators (e.g., 5/6 - 1/6 =).

B. Problems that do not have common denominators — and therefore require student to determine common denominator (e.g., 3/4 - 1/2 =). These shall include problems that:

1. Require student to use rule No. 1. (Smaller denominator divided into larger -- e.g., 3/4 - 1/2).

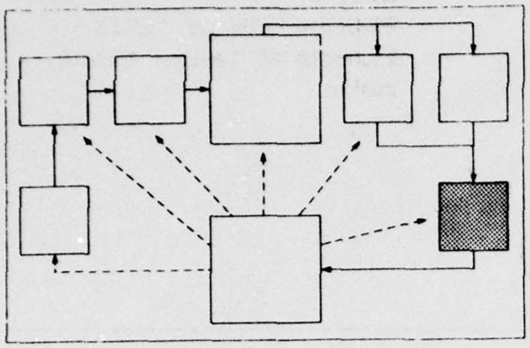
2. Smaller denominator will not divide into larger (e.g., 3/5 - 1/3).

C. Problems that require student to reduce. Reducing problems should include those in which:

1. The numerator will divide into the denominator with no remainder (e.g., 5/8 - 1/8 = 4/8 = 1/2).

2. The numerator will not divide into the denominator with no remainder, however, both the numerator and denominator are even (e.g., 5/6 - 1/6 = 4/6 = 2/3).

3. Either the numerator or the denominator is odd (e.g., 8/9 - 2/9 = 6/9 = 2/3).



STEP 6:
TRAINING
The use of instructional materials with students.

Training is actually part of the instructional development process, as well as the end product of that process. In order to validate instruction (i.e., prove that it does indeed work) the instruction must be presented several times. Each time the course is presented, the quality control phase (step 7) of a systems approach is activated to produce a careful evaluation of student performance and other factors which, in turn, will be used to determine what changes must be made to improve the instruction. The effect of training on actual students is the final determiner of the effectiveness of or need for more work on any instructional materials, and courses continue to be presented, evaluated and refined until acceptable levels of student performance are achieved. Only then are the procedures (including instruction to teachers, testing programs, etc.) and results documented and the materials made ready for general use.

During instructional planning and during instruction itself, special care is taken to ensure that for each student, instruction begins at the point of his or her entry level of performance and, in the most efficient way possible, proceeds to a point where performance is consistent with course objectives. Generally, several different methods and media are necessary to:

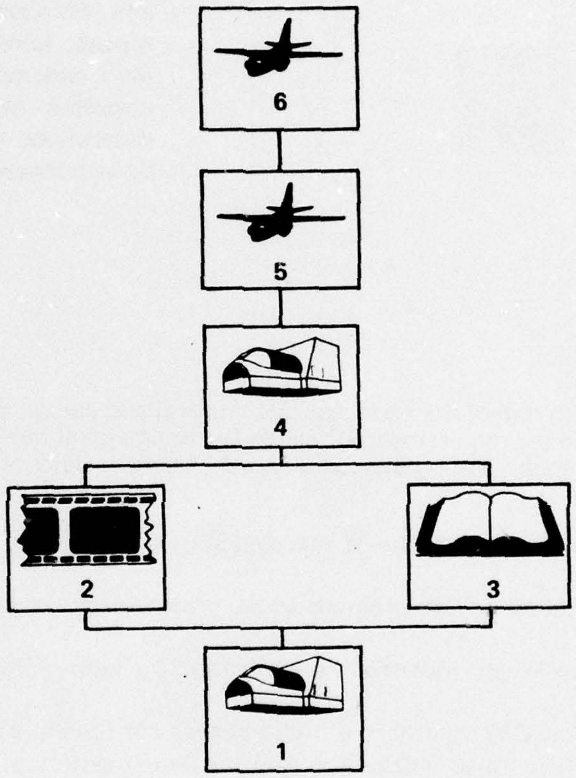
1. Satisfy the various instructional needs identified in the objectives of a course.

2. Keep instruction interesting and palatable for students.

A typical lesson map showing title of lesson segments and the media used in those segments is shown at the right. In this example, students would begin with a flight simulator exercise (1) and make use of tape-slide (2) and workbook segments (3) to learn basic procedures, concepts and rules and then move on to simulator (4) and actual flying exercises (5) to help them achieve the final lesson objective (6).

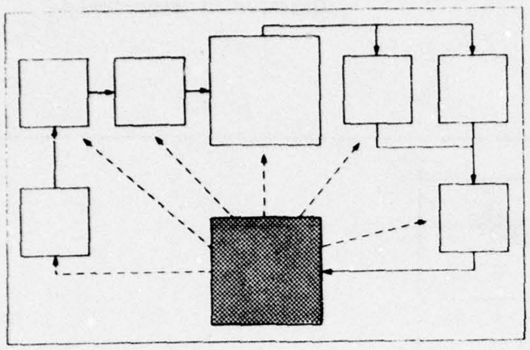
Managing or implementing instruction, so that a great variety of methods and media used during training are used in a manner consistent with the great variety of instructional needs of the students, requires considerable preplanning, and often pretraining of administration, instructors and instructor aids. All too often instructional systems reach less than their true potential because of poor implementation. The importance of this phase should be obvious, since it is not until we actually train students that we see the results of all the analysis and development that went on in earlier steps. Therefore, care must be taken throughout the instructional development process to ensure that actual implementation will be practical. The multitude of instructional components must be designed so that they can be integrated to produce smooth transitions and easy management of the instructional system.

STEP 6:
TRAINING
Example of lesson map.



SEGMENT TITLES

1. Instrument panel scans
2. The instrument approach plate
3. Procedures for landing approaches
4. Normal approaches (exercise)
5. Instrument approaches (exercise)
6. Landing approaches



STEP 7:
QUALITY CONTROL
The process of evaluating the instructional program to determine its effectiveness and efficiency by empirical means, followed by the revision and modification of instruction which has been determined to be inadequate or unsuccessful.

In accordance with one of the basic assumptions outlined earlier, the Contractor strictly adheres to the requirement for validation or empirical testing of any instructional program. During the quality control step we determine whether:

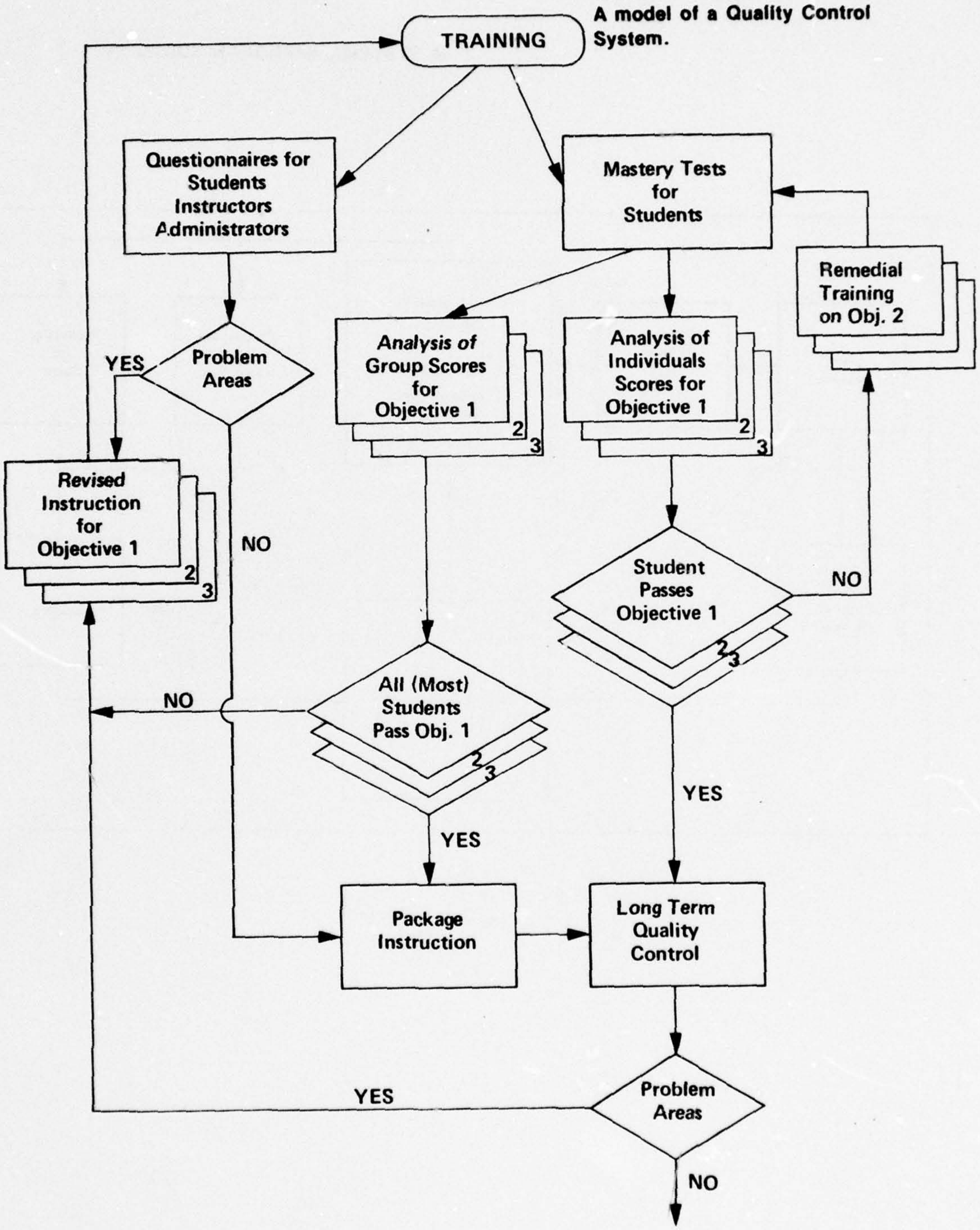
1. The instructional program is meeting its stated goals.
2. Implementation of the program in its present form is practical.
3. The graduates are meeting the competency needs of the real world.

This means that quality control is a broad-based, continuing evaluation/revision program which fine tunes instruction and its implementation.

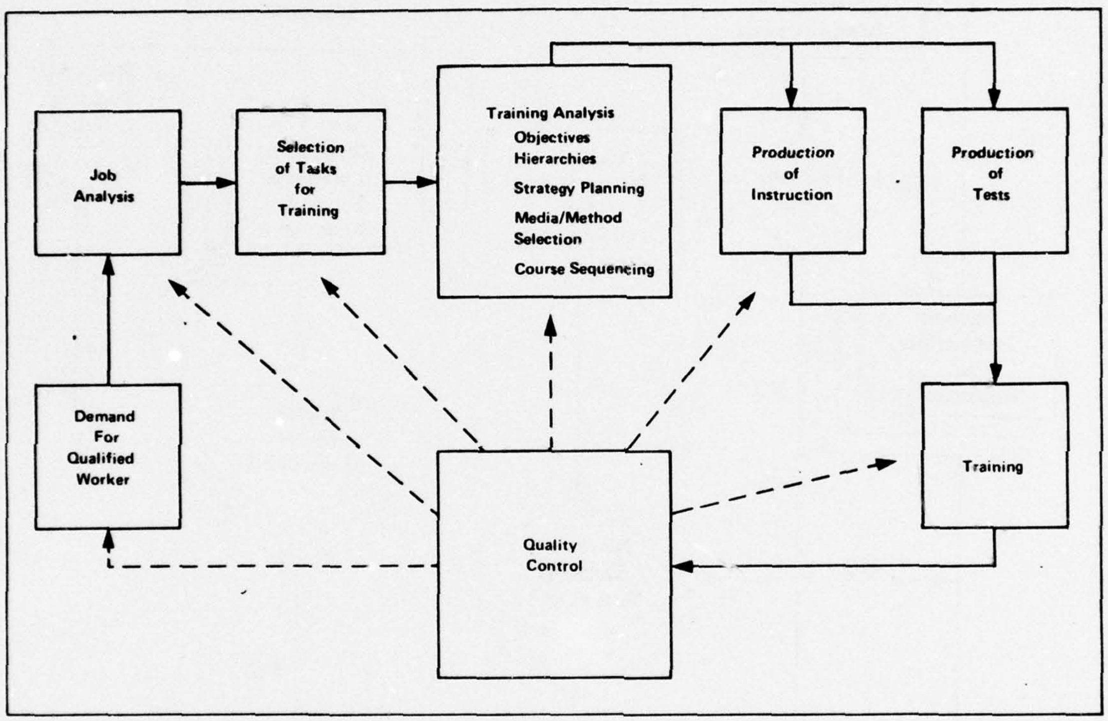
A wide variety of evaluation instruments are used to provide the data base for quality control. Probably most important are tests which measure mastery of instructional objectives. However, student attitude surveys and teacher comments are also used to identify weak points in the instruction so that revisions can be made. Post-graduate field surveys are used to assess the relevance of course content to real world tasks, as well as the appropriateness of the competency levels of instructional objectives. These data are also fed into the revision system.

A good quality control program consists of a broad data collection effort and a consistent and conscientious attempt to revise instructional materials based on that data. It ensures that instruction will be efficient, effective and palatable, as well as ensuring that it will be relevant to the ever-changing needs of the students and those who use their talents after graduation.

STEP 7:
QUALITY CONTROL
A model of a Quality Control System.



A SYSTEMS APPROACH SUMMARY



The systems approach can be viewed as an attempt to answer these three basic questions:

What should be taught?--The answer is provided not by teacher insights or administrative whim, but through extensive data gathering. What to teach is decided by finding out exactly what tasks a job holder performs (job analysis) then determining which of these tasks are best met by a training program and which are best handled through specifying job prerequisites or through on-the-job training. (Selection of tasks for training.)

How should it be taught?--The answer is provided through extensive training analysis. Hierarchies are developed which specify both end-of-course proficiencies and interim proficiencies leading to end-of-course skills. Media/method designations are made, based not on arbitrary preference but on learning requirements. An instructional strategy is developed to allow for optimum learning on each objective. An overall course sequence is planned to maximize both learning and affect.

Has it been taught?--The answer comes from extensive evaluation of student proficiency throughout the course. The course itself is evaluated through a comprehensive quality control program to ensure efficiency and effectiveness of instruction--as well as continued course relevance to real world job requirements.

Although this systems approach involves a series of specific procedural steps, this does not mean to imply that human judgment can be abandoned during course development. The systems engineering approach helps to organize and direct the thinking required in course design; it does not make judgments or decisions on some kind of automatic basis.

Appendix B

Detailed Technical Approach

This Appendix is an extract of the Work Plan Report (Contract Data Item 0001). It presents a detailed account of the basic ISD model used and specifies how the model was going to be employed on the EA-6B project. The original document contained other material, including background and rationale for ISD. None of this has been included in this Appendix. The only focus is on the detailed steps in ISD.

Job Analysis

The first step in ISD is Job Analysis, which involves a detailed analysis of what is done on the job. The term "task analysis" is also used to describe this activity since the basic output of this first step is a detailed list of tasks performed on the job. All tasks which are necessary to job performance must be identified in order that the later steps in development can build on a complete and solid base, and so that the developed instruction will, in fact, prepare individuals for competent job performance. Tasks are identified and specified in a listing which includes what is done (action), the object of the action (e.g., equipment used, personnel supervised, performance evaluated), and the minimum standards set for performance. A task listing will be completed and validated for each crew position on the aircraft.

Several methods can be used to gather task analysis data. These include the analysis of factory supplied resource documents, observation of on-the-job performance, and questioning of job holders, their supervisors, and others who are familiar with the tasks performed by the aircraft crew. Since the EA-6B ICAP version aircraft is still on the drawing boards, not all of these methods will be able to be employed.

The initial task analysis document will be developed by subject matter experts (SMEs) who have had considerable experience in the Standard and XCAP versions of the EA-6B, and who know the specifications for the ICAP version. The SME will be using the task listing algorithm shown in Figure B-1 to guide their analysis. The algorithm basically walks the SME through three major groups

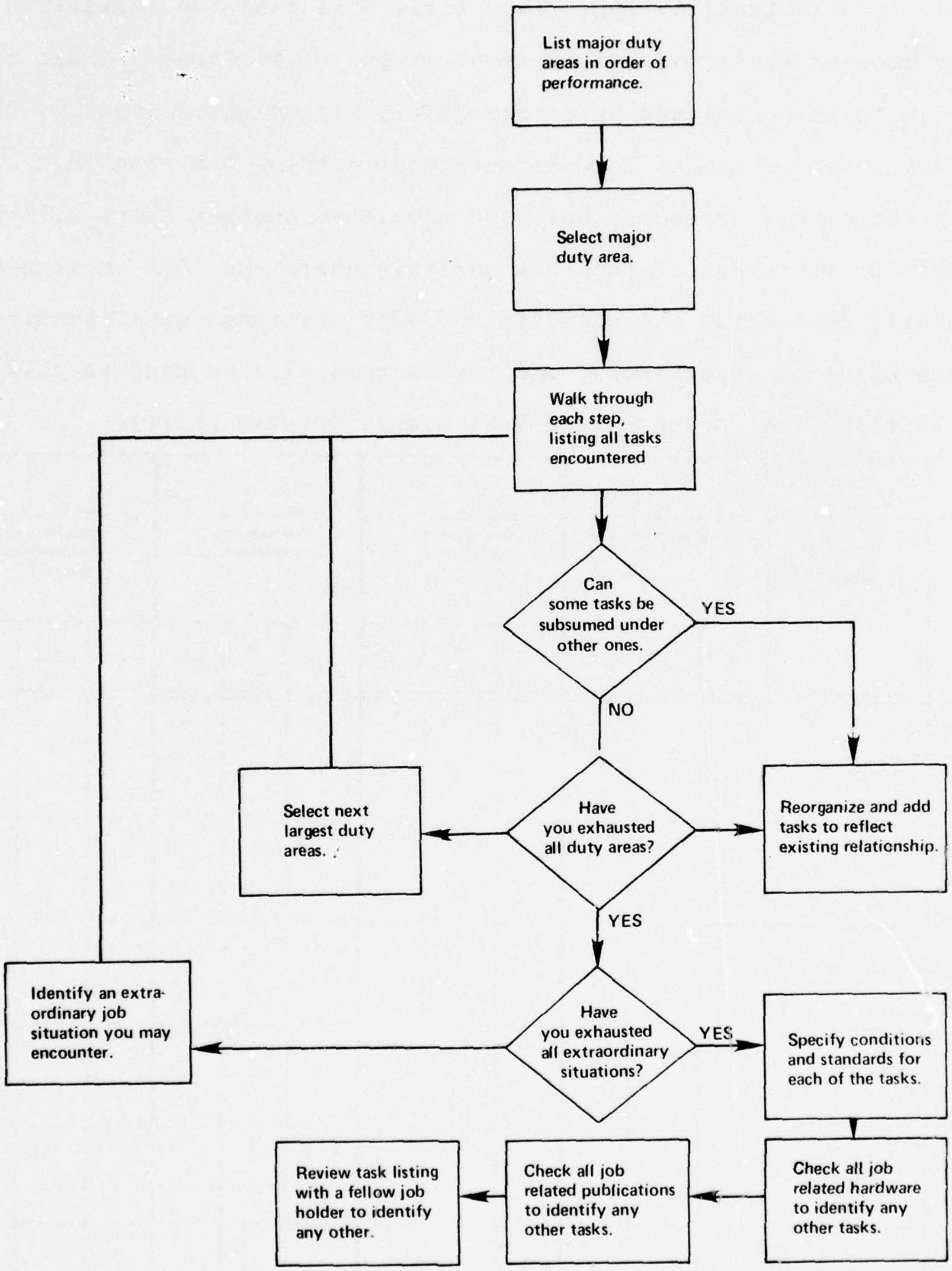


Figure B-1. Task Listing Algorithm

of steps in task listing. They first will list the tasks involved in each of their major duty areas (types of missions). Next they list tasks occasioned by extraordinary situations. Finally, they perform a set of checks to make sure that nothing has been left out.

Once this procedure has been completed another check will be conducted. In areas of the task analysis where the ICAP version essentially duplicates the standard and XCAP versions, questionnaires to job holders, supervisors, and instructors will be used to validate the task list. (See Figure B-2, Sample Questionnaire).

TASKS	How frequently do you perform this task?			How soon after training did you first have to perform it?			Where did you first learn how to perform it?			How closely are you supervised when performing this task?		
	Never	Some-times	Often	0-3 mos	3-6 mos	Over 6 mos	On Job	In Schl	Other	None	Spot	Close
1. Prepare strength reports												
2. Perform surgical airway												
3. Make red blood count												
4. Present training lectures												
5. Order supplies												
6. 7. Etc.												

Figure B-2. Sample Job Analysis Questionnaire

Once the task listings have been completed, they will be augmented with statements of minimum job performance standards (if these are not already recorded) and recorded in the task inventory document. A sample task inventory document is shown in Figure B-3.

TASK STATEMENTS	Frequency of Task Performance*	Time on Job Before Task Performance is Required (in mos.)	Per Cent of Job Holders Learning Task at: Job	Schl	Other	Average Supervision Rating*
1.0 Determine CRT/SC operability according to procedures outlined in NATOPS.	3.0	3		100%		1.0
1.1 Enter CRT/SC test pattern so that pattern appears on all attempts.	3.0	3		100%		1.0
2.0 Determine ARU operability according to procedures outlined in NATOPS.	3.0	3		100%		1.0
2.1 Enter ARU test pattern so that pattern appears on all attempts.						
3.0 Apply power to MPD according to procedure outlined in NATOPS.						
3.0 . . . 3.2 . . . etc. . . .						

* Reflects average rating of frequency of performance: 1.0 = never performed; 3.0 = often performed.

** Reflects average of ratings: 1.0 = no supervision; 3.0 = close supervision.

Figure B-3. Sample Task Inventory Document

In addition to the task listing and validation, an important early step in ISD should be to gather information on project limitations (funds, personnel, equipment, etc.), existing instructional assets (instructional materials, instructor qualifications, simulators, potential for use of static aircraft, etc.) and job constraints (supervision available, time available for training, etc.). These data are recorded in narrative form and are used as part of the final Job Analysis report.

The Job Analysis phase requires high level instructional psychology effort for the design of instruments, training of SMEs in task listing techniques, quality control of the task listing procedure, and analysis of critical job constraints and existing instructional assets. SMEs are required to control the content of the task listings and to review and interpret technical documents.

Selection of Tasks for Training

Once a complete list of job tasks is developed, it will be analyzed to determine which ones should be taught in formal training programs, which can be taught after assignment to squadrons, and which need not be taught at all. In making this determination, information gathered with the job analysis questionnaire is combined with SME experience to determine task criticality and frequency of performance, the number of persons performing the task, the need for specific task performance in early phases of job assignment, and the practicality of training within the Fleet squadron. Additional information is then collected concerning the entry level of performance of students.

A project-specific model for selecting tasks for training will

be developed, such as the one previously used by the Contractor and presented as Figure B-4. This decision model is used to screen all tasks to ensure that formal training covers only those tasks which (1) students cannot already perform, (2) cannot be particularly well taught on the job or in later training programs.

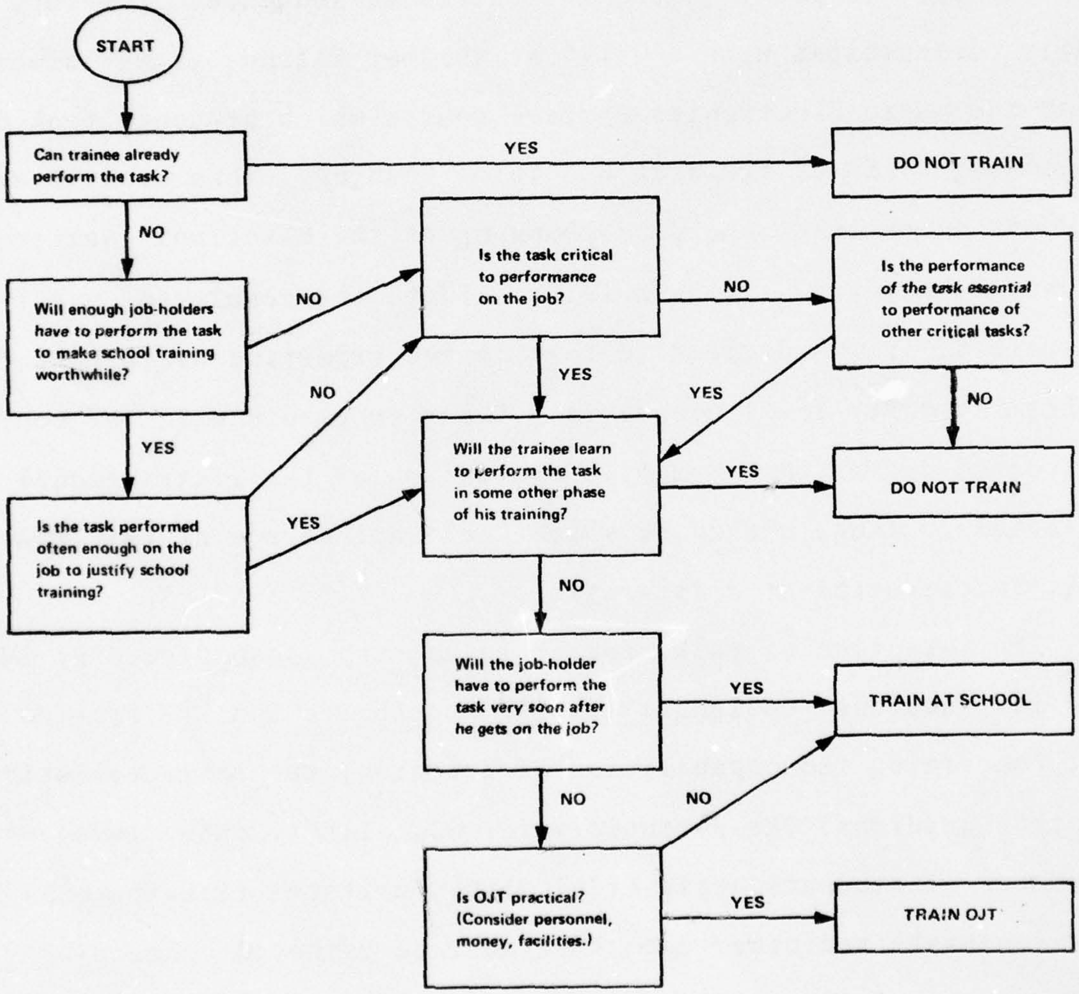


Figure B-4. Decision Model for Selecting Tasks for Training

The primary output of this second ISD step is a revised task list which includes only those tasks which require formal training. Related documents describing tasks considered to be a part of entry level skills, and tasks identified as potential content for OJT or later formal training programs are also prepared. The entry level skills description can be used in developing diagnostic entry level tests which ensure that all students begin training at the appropriate point in the instructional sequence. However, early discussions with VAQ-129 at Whidbey Island, it was discovered that the basic Electronics Warfare course which students took prior to coming to EA-6B training was to be changed. This meant that the student entry level would be changing as the Electronic Warfare course is altered. This would invalidate the results of any tests. Therefore, it was decided to rely on the expertise of the SME to determine entry level behaviors. Their judgments will, of course, be tested during the formative evaluation of the instructional materials. Thus, the check which could not be run at this time will be conducted at a later time.

The selection of tasks for training step is completed by SME and instructional designers working together. The SME provide input concerning the capabilities of training, the characteristics of the squadrons, the potentials for OJT, likely entry level performance of students, task criticality, critical relationships between tasks and other data that must be gathered concerning the content of the task listing and the nature of the operation system. It should be noted that active duty Navy personnel are likely to be best suited to provide this input. Instructional

psychologists, on the other hand, can develop instruments to verify entry performance estimates and relationships between tasks, as well as supervise the process of task selection.

Training Analysis

The training analysis is the most critical step in ISD because it is during this step that tasks are converted to training objectives and the training objectives are then used to develop the lesson specifications which guide the development of instructional materials. If the set of objectives specified is not complete and the relations between objectives not accurate, training will not be complete and serious performance decrements will almost surely occur. In addition, if lesson specifications are not based on sound instructional principles, are not complete, and/or not easy to interpret by instructional development teams, the instruction produced will surely not meet high standards of effectiveness, efficiency or palatability. A failure of the instructional design team in this phase of ISD will surely result in wasted expenditures for instructional development, training and/or training equipment, increased training time and poor student morale.

Developing Behavioral Objectives

The writing of behavioral objectives has long occupied the time of training personnel, and several books, articles and guides to the proper formatting of these objectives are available. However, few guides are given to the most critical aspect

of the objectives development: the methods used to produce complete lists of objectives and to specify the subordinate and coordinate relationships between those objectives.

The Contractor subscribes to the proposition that training objectives must specify precisely what behavior is to be exhibited, the conditions under which the behavior is to be accomplished and the minimum acceptable standards of performance for those objectives. Objectives stated in this way are extremely useful to the developer of instructional materials and the developer of tests. To ensure that training objectives will prescribe instruction which is relevant to job performance, end-of-course (terminal) objectives should be the result of direct conversion of major task statements into instructional objectives form. To ensure that instructional objectives also prescribe all of the instruction required to bridge the gap between entry level performance and end-of-course objectives, intermediate or supporting objectives must also be developed. These supporting objectives represent the more basic skills, knowledges and attitudes that must be learned.

The most effective means for developing these supporting objectives is to perform an objectives hierarchy analysis. The objectives hierarchy which results from this procedure identifies supporting and end-of-course objectives as well as the subordinate and coordinate relationships between objectives. These relationships between objectives are very important later on when the sequence of instruction is established.

The instructional designers and SME work together during this phase to develop the objectives hierarchies. Care must be taken throughout this step to ensure that required operator functions, not machine functions, are the determiners of the objective statements. Care should also be taken to ensure that objectives include the requirements of tactical decisions. This means that Navy SME are most valuable during this phase of ISD.

Media Analysis

This phase of the training analysis is critical in identifying training support requirements and in achieving efficient and effective use of resources. All too often this phase of an instructional development project falls victim to one or more serious misconceptions. One such misconception is that media usage and selection is an equipment-oriented process. That is, the question being asked is "How best can we use a given piece of equipment?" This is essentially the "solution in search of a problem" approach. What is needed is a "problem in search of a solution" approach in which instructional requirements or needs are identified first, and then media are reviewed or designed considering these needs.

Another common misconception is that there is one universally appropriate instructional method or media, and once that is identified or developed, media selection will no longer be a problem. Such a misconception has led many developers to propose an instructional "panacea", a device or method that will solve all

instructional problems. Programmed instruction and computer-assisted instruction have had their day as panaceas and have proven, as one should expect, to be both highly successful and woefully wanting, depending upon the content and instructional objectives being taught.

The approach that will be taken by the Contractor is that there are two basic principles that should underlie any method and media selection model. First, methods and media should be appropriate to the requirements of a particular learning situation. Second, the least expensive and least complicated method that will teach effectively should be used.

The diagram presented as Figure B-5 provides an outline for considerations and processes that are critical in method and media selection. The problem shown at the top of Figure B-5 incorporates the standards for judging a method/media selection model that are generated from the two principles stated above. The figure indicates that an acceptable media selection model should consider the teaching capabilities implied by the kinds of objectives that the student must achieve. It is known that the kind of learning involved in an objective (e.g., memorization, concept learning, rule using, problem solving, psychomotor skills) will place certain minimal requirements on the instructional media. For example, memory level objectives require a presentation that clearly differentiates stimulus and response elements and delineates precisely what is to be learned, while providing an opportunity for self-paced practice. Concept and rule learning objectives require succinct statements of definitions or rules, a rich set of illus-

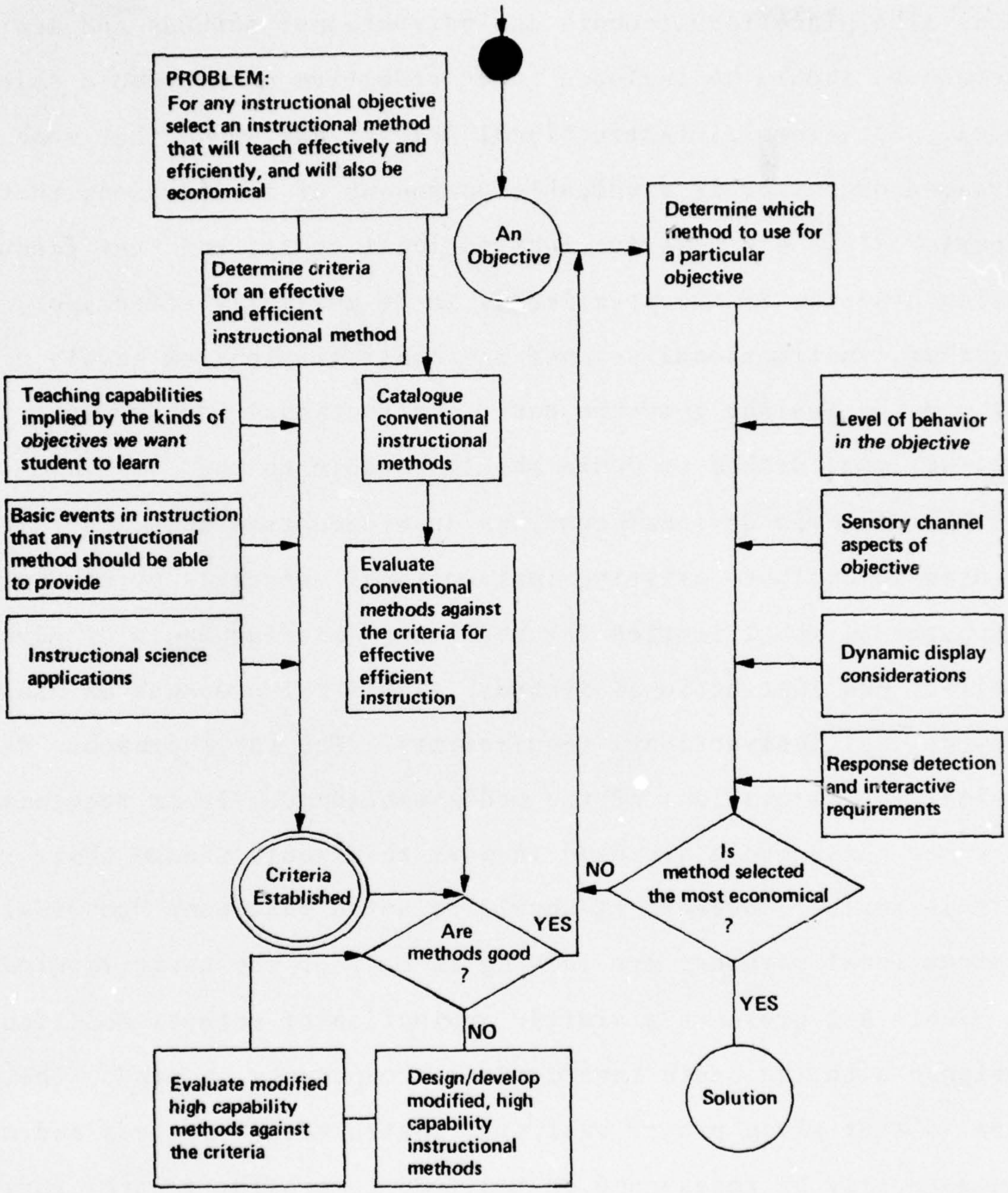


Figure B-5. Critical Considerations and Processes in Media Selection

trative examples, and an opportunity for practice with corrective feedback.

Instructional science provides an additional source of assumptions concerning effective instructional strategies. These assump-

tions also place requirements on instructional methods and media and, therefore, should be included in an effective method/media selection model. For example, instructional science has shown that some form of advanced organizer is a valuable component of instruction, that instructional "helps" are powerful instructional tools, and that feedback must follow practice if the practice is to be maximally effective. Taken together, instructional science and considerations of levels of learning provide insight into the basic instructional requirements that any instructional method or media should be able to meet.

The criteria or considerations developed from this analysis can be used to evaluate existing instructional materials or can be used as a functional specification for modifying existing media or developing entirely new instructional systems. Table B-1 presents an analysis of conventional instructional requirements. The table presents data on typical implementations of the media mentioned. It is recognized that at times these media are used in ways that would change their ratings on this table. However, it should be noted that many "conventional instructional methods" are lacking in many of the basic requirements.

Table B-2 presents a similar evaluation of methods modified or designed with the basic instructional components in mind. The point here is that given proper analysis, instructional methods and media can generally be redesigned or modified to provide greater instructional capability. Once these expanded-capability methods have been designed, they can be built into a method/media selection model like that presented in Figure B-6. This model, which was developed by Courseware, Inc. for the S-3A Flight Crew Training Program, was used

TABLE B-2. THE ABILITY TO CONVENTIONAL INSTRUCTIONAL METHODS TO PROVIDE ESSENTIAL INSTRUCTIONAL CAPABILITIES

KEY: YES (shaded) NO (unshaded)

	BASIC OR ESSENTIAL INSTRUCTIONAL CAPABILITIES							
	Introductory Capabilities	Expository Capabilities			Inquisitory Capabilities		Flexibility and Adaptiveness Capabilities	
Conventional Instructional Methods	(Including objectives, motivation, directions, and instructional sequence relationships)	Generalities	Supporting Explanations	Instances	Practice	Test With Feedback	ID of Learner Needs	Dynamic Modification and Helps
Lecture (Expository)					PARTLY		POORLY	
Videotape or Film								
Audio-Visual					POOR			
Model								
Audiotape	FAIR			POOR				
PI Text			PARTLY				PARTLY	PARTLY
CAI								
Seminar/Discussion								PARTLY
Demonstration								
Text/Pamphlet					POOR	POOR		
Simulator								
Practical Exercise								

TABLE 3. THE ABILITY OF MODIFIED INSTRUCTIONAL METHODS TO PROVIDE ESSENTIAL INSTRUCTIONAL CAPABILITIES

KEY: YES (shaded) NO (blank)

	BASIC OR ESSENTIAL INSTRUCTIONAL CAPABILITIES							
	Introductory Capabilities	Expository Capabilities			Inquisitory Capabilities		Flexibility and Adaptiveness Capabilities	
Modified Instructional Methods	(Including objectives, motivation, directions, and instructional sequence relationships)	Generalities	Supporting Explanations	Instances	Practice	Test With Feedback	ID of Learner Needs	Dynamic Modification and Helps
Mediated Interactive Lecture (M.I.L.)								
Audio-Visual or Videotape with Worksheet								
Model and Worksheets					PARTLY	PARTLY	PARTLY	PARTLY
Workbook								
CAI								
Simulator with Worksheet								

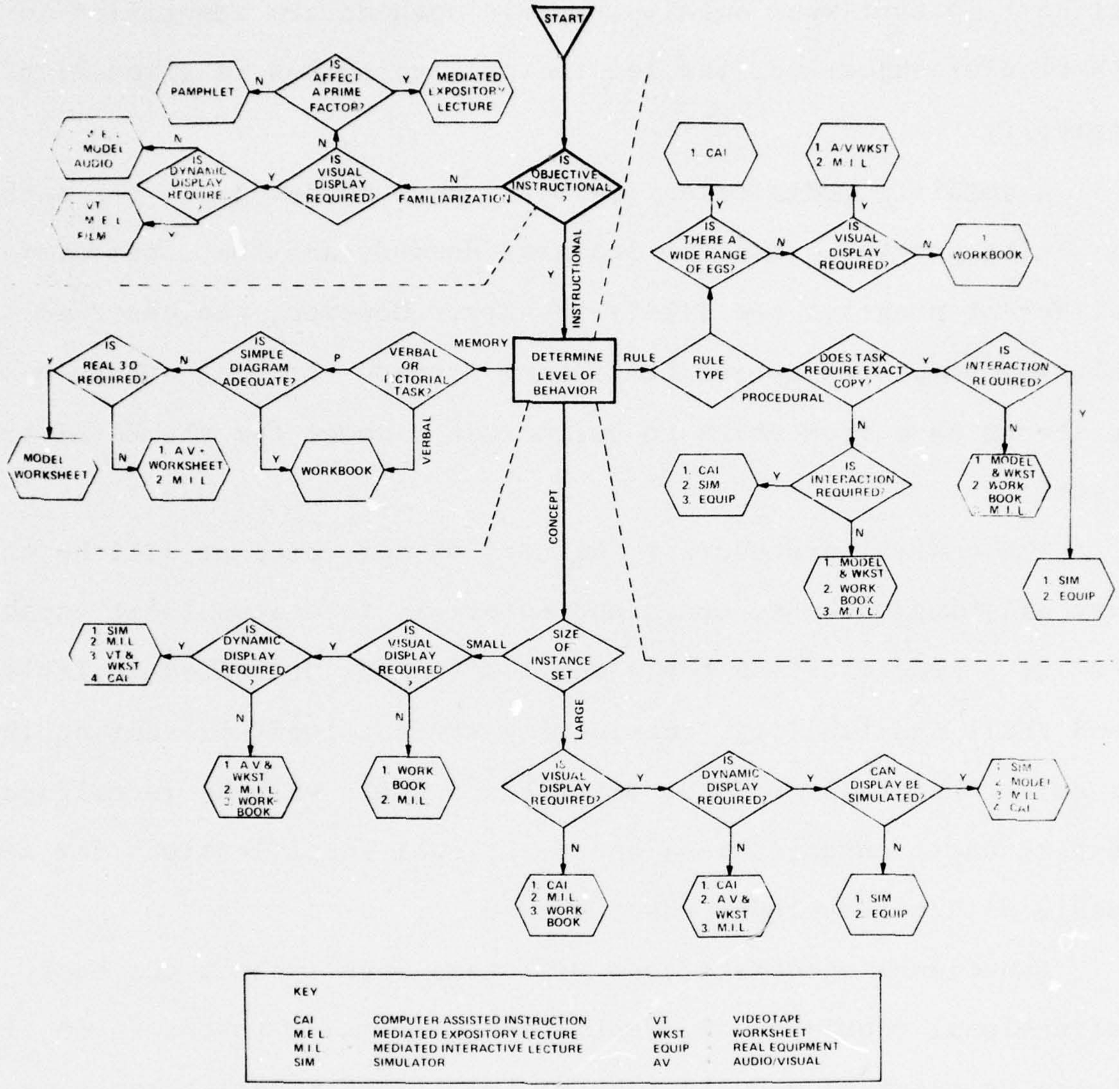


Figure B-6. A Sample Method/Media Selection Model

to select methods and media suitable for teaching individual objectives. The model incorporates the level of behavior of objectives (memory, problem-solving, etc.), sensory demands of the objective (e.g., sight, sound, feel, etc.), dynamic display requirements (is movement required) and response detection and interaction requirements (how the student will respond to and interact with the instruction). In addition, it incorporates factors

of cost in that when equally capable methods are identified for a particular objective, the least expensive method is given higher priority.

A specific media selection model must be developed for each training program since the learning demands and the constraints of different programs are likely to vary. However, the basic work already completed by the Contractor provides a solid approach and a strong base from which to build such a model for the EA-6B project.

The general procedure to be used on this project will be to survey existing methods, media and materials to assess their capability (using a specification table similar to that presented in Table B-1) and their availability (considering student load, present equipment, etc.). Once this is done, methods and media will be redesigned to expand their capabilities, and functional specifications for new media will be developed where needed.

Functional specifications will take into account the basic instructional requirements, requirements peculiar to the EA-6B (ICAP) training program, and the most useful instructional strategies known to instructional science. Finally, cost models appropriate to each method or media will be developed. In the past, such cost estimates have seldom considered all factors and have therefore generated inaccurate reflections of the true cost picture. It is proposed that an in-depth cost analysis be made for each method or media to include costs of initial purchase or redesign of equipment, personnel and material costs associated with developing a lesson, proctor and/or supervision costs associated with using a method or

media, running costs (e.g., electrical and maintenance costs) and costs of changes to content. The elaborated cost model that results from this analysis will be incorporated into the method/media selection model and can be validated during follow-on work in Phase II.

Once an acceptable model is developed, each objective will be "processed" through the model and method/media selections made. The end product of this process is a two-part document that (1) describes in detail each method and media that is used in the model and (2) provides a map of instructional units or chunks, and media selection for each.

The analysis of existing methods, media and materials, and the development of the method/media selection model is primarily the work of on-site instructional designers. Cost data will be gathered with the help of Navy training personnel, equipment companies, and the previous experience of the IPs.

Sequencing Instruction

There are several levels at which instruction may be "sequenced". For example, early in the design phases of instructional development, the objectives identified for a given course can be ordered in such a way as to outline the general flow of instructional content. Later, a more fine-grained sequencing of instructional components within lessons and segments becomes a major part of the instructional strategy specification. This section deals with the more general sequencing of objectives.

There are three basic principles that are employed by the Contractor in sequencing course objectives. These are the prin-

ciples of hierarchy position, "early hands on" and "most difficult and most important objectives first."

If completed properly, the objectives hierarchy provides a major insight into the logical or prerequisite relationship between course objectives. Within any objectives hierarchies, lower level objectives should be prerequisite to higher level objectives and, therefore, should normally be taught first. However, a given hierarchy does not necessarily prescribe the exact teaching sequence for all objectives. For example, in Figure B-7 a prototype hierarchy is depicted.

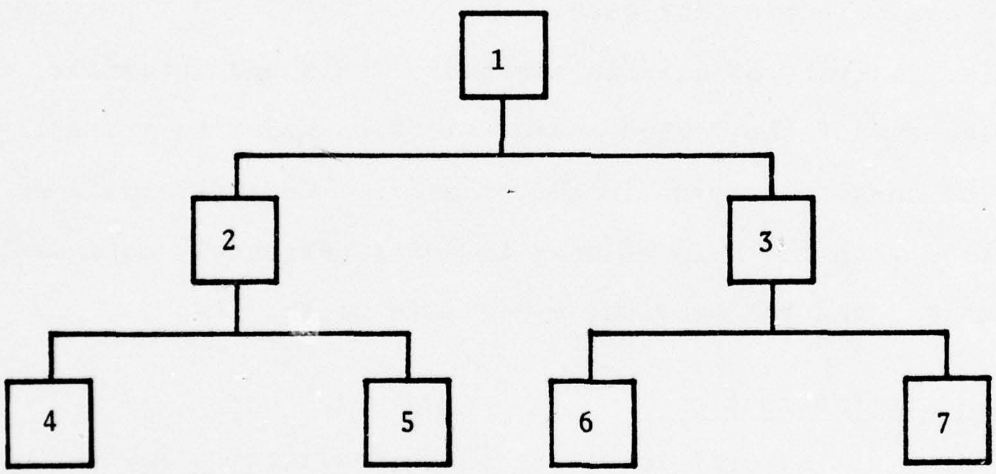


Figure B-7. A Prototype Hierarchy

The hierarchy indicates objectives 4 and 5 are prerequisite to objective 2; objectives 6 and 7 are prerequisite to objective 3; and objectives 2 and 3 are prerequisite to objective 1. However, two possible sequences could be used to teach the objectives in this hierarchy. The basic objectives (4, 5, 6, and 7) could all be taught before proceeding to objectives 2 and 3. Or objectives 4 and 5 could be taught first, then objective 2, before moving

on to objectives 6, 7 and 3 and 1. In the first case, we would be employing an "all basics first" sequence, while in the second case we would be employing an "early hands on" sequence. These sequences are shown in Figure B-8.

Even though the "all basics first" sequencing is logical and orderly, it has serious drawbacks. It keeps students in a purely theoretical or memorization-of-basics mode for long periods before they are able to move on to the more rewarding application-type objectives. Generally, students in a training program are anxious to get on to using real world equipment, or solving real world problems and, therefore, an "all basics first" sequence can have serious negative effects on motivation.

The principle of "early hands on" states that within the constraints of prerequisite levels of learning, it is generally better to teach one vertical leg of a hierarchy, then the second vertical leg, and so on in order to bring students into contact with the more applied objectives (i.e., objectives that are likely to involve "hands on" work with equipment used on the job) as soon as possible and on a more regular schedule throughout the course.

The "most difficult and most important objectives first" principle indicates that it is often wise to begin instruction by teaching those objectives which are most critical in terms of job performance or those objectives which are likely to be most difficult to learn. Although it is common and seems logical to sequence the end-of-course objectives to parallel the normal sequence of job tasks, this often results in teaching

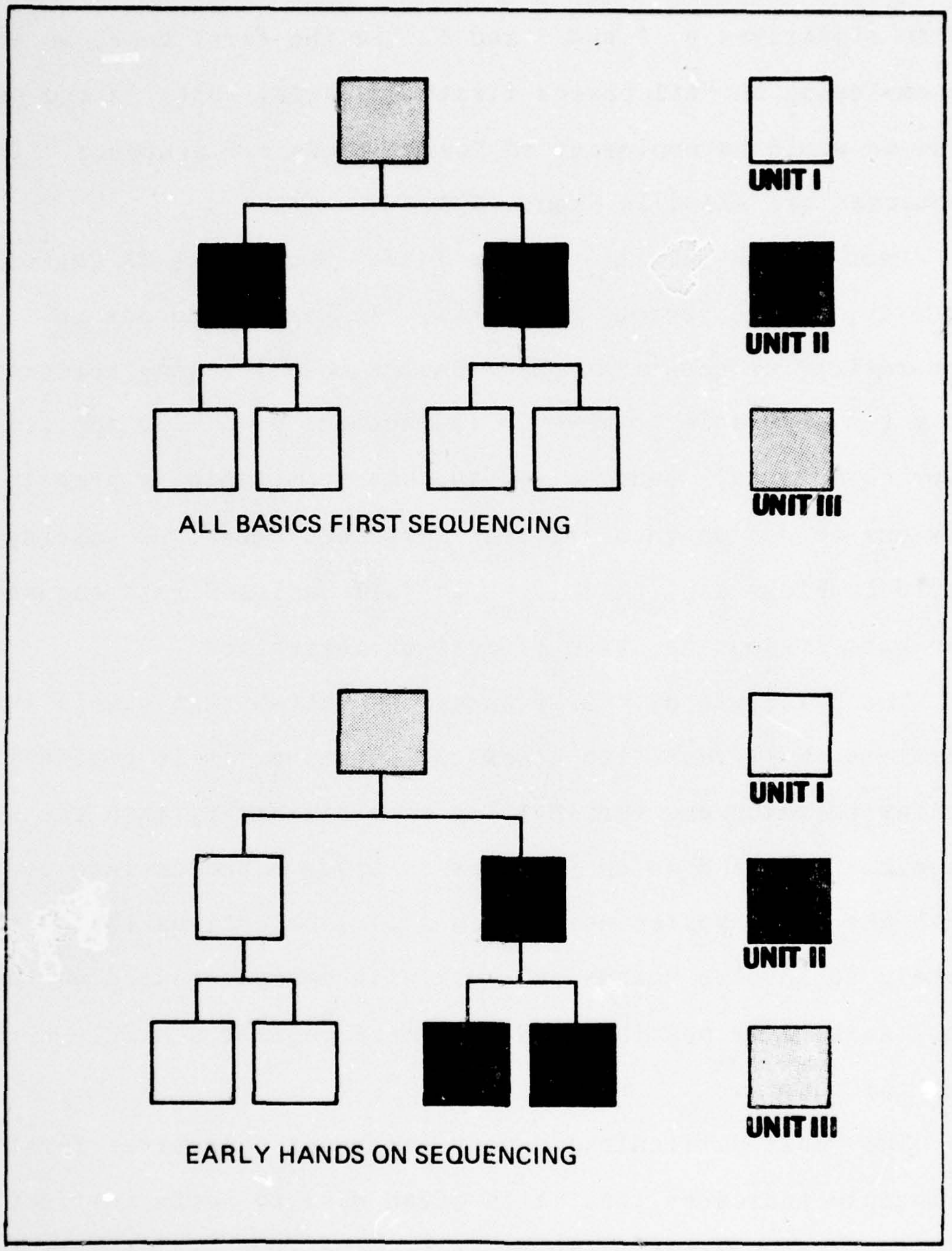


Figure B-8. All Basics First/Early Hands on Sequence

the simplest and least important performance requirements (e.g., entering the aircraft, applying power to equipment, etc.) first, while more difficult and critical tasks (e.g., radar interpretations, jamming techniques, etc.) are taught nearer the end of the course.

Since tasks taught early in the course have a high probability of receiving more practice and have more potential for remediation, a "most difficult and most important first" sequence can have significant positive effect on end-of-course performance. Applying this principle can also result in motivational benefits since it ensures that students will be constantly more aware of the relevance (in terms of end of course performance) of their instruction.

The instructional designer and subject matter expert work together during this step of the systems approach to identify critical or difficult items of content, to identify objectives that do involve "hands on" experience, and finally to apply the sequencing principles.

Organizing Instructional Blocks

During this phase, the course is organized into administrative components which will indicate to students and instructors the boundaries between major organizational divisions of the course, points at which methods or media are likely to shift, points at which tests will be given and places where decisions will be made as to the progress of individual students. The terms "unit", "lesson" and "segment" are used to differentiate these components; units designating the largest instructional chunks and segments

the smallest.

The segment designation is used to refer to instruction related to an individual objective.

Segments are the course component for which method and media decisions are initially made and for which individual strategies are developed.

Segments which teach related content are organized to form a lesson with a single, high level objective. Lesson objectives can generally be accomplished in one sitting by the average student, and generally involve easily integrated methods or media. Primarily, however, the lesson teaches a related body of content and teaches to an objective which is considered worthy of being a mastery checkpoint. That is, the lesson test provides a decision point from which students are either passed on to a new lesson or routed back through some form of remedial instruction.

The unit designations provide another checkpoint. They are used to designate larger related bodies of content which generally lead to the accomplishment of integrated, terminal performance objectives. Units consist of a number of related lessons.

Minor changes in media selection can be made at this point in order to facilitate lesson and unit organization. As was mentioned earlier, the media selection process should result in more than one acceptable medium. If cost and resource factors are equal for two potential media choices, the one most easily incorporated into a lesson or unit may be decided upon at this point.

During this step, SME most familiar with the eventual training environment work with instructional designers to determine media

integrations, estimate training times and organize the instructional blocks (units, lessons and segments). The end product of this step is a revised version of the "Maps of Instructional Components and Media". A map is a visual representation of the instructional organization and sequence. For all practical purposes, it is a syllabus.

Instructional Strategy Determination

An instructional strategy is a specifically designed arrangement or sequence of instructional components and displays. There are basically two decisions in developing instructional strategies: the type of instructional components to use, and the way they are sequenced.

There is considerable empirical evidence that bears on the formulation of sound instructional strategies. The theoretical and developmental work upon which the present approach is based is too technical for presentation in this document. This section will present some of the basic ideas.

Considering the first decision that goes into instructional strategy selection, it has been found that three basic components are necessary for most instruction. These are general statements which present definitions of concepts or specify the steps in procedures and rules; illustrative examples of a concept or the application of a rule; and practice situations, with feedback, which require students to identify concepts or apply rules themselves. Each of these three basic components can be augmented by a fourth component: instructional "helps". Helps consist of information which simplifies the general statement or makes it

easier to use. Helps may take the form of an elaboration or an algorithm, or a thoroughly explained example.

There are other components that are generally valuable in instruction. These include statements which provide the student with an overview of the instructional content (advanced organizers), a rationale for what he is about to learn, and a specification of the desired outcome of the instruction (objectives).

The second decision in instructional strategy determination concerns the sequencing of these components in a piece of instruction. There are several questions involved in this decision about arranging instructional components: how many different examples and practice items are needed to illustrate a given concept definition or a rule? in which order should the components be given to students? should example presentations be paired with non-example presentations? where should "helps" appear in the sequence? There is sufficient evidence from instructional research to formulate guidelines for developing instructional strategies.

The instructional designer is the primary architect of the instructional strategy. The componentized approach makes it possible for the instructional strategy to be specified in outline form, with the instructional content then supplied by SME to meet the specification. The complete lesson specification is the result of the combined efforts of instructional designers and SME, with strategy components being supplied by the former and the content components being supplied by the latter.

The lesson specification is the final product of the training analysis and includes all of the information generated during this

step.

A lesson specification format is shown in Figure B-9. The lesson specification must be complete and must be interpretable by the instructional development team if it is to be useful in providing effective guidance to the development effort.

The Evaluation of ISD

The implementation of the ISD approach just outlined will be the major emphasis of the EA-6B (ICAP) ISD project. However, this project also involves an analysis and evaluation of the ISD models, algorithms and techniques, and their applicability and resource demands within the setting of applied flight crew training programs. This analysis and evaluation will require some design and implementation efforts over and above those required by the ISD implementation.

A detailed record will be kept of the specific activities conducted during each step in ISD, the time and money expended, and the personnel involved in each. Each activity will be described in terms of the philosophy and assumptions underlying it: the models, algorithms and techniques used; the training given to SME prior to and during implementation; and the end and intermediate products developed.

Still, many of the models, algorithms and techniques developed or employed in this project will have to await the completion of Phase II in order to be validated. For example, the task analysis can be validated only after instructional development and actual training has occurred. Detailed cost and media selection models, course sequencing and organization into blocks and instructional

*1. Lesson Title, Number & Unit Reference

2. "So What" Statement
   a. Rationale (Importance) of lesson
   b. Relationship to other lessons
   c. Job-related aspects of lesson

3. Sequenced Lesson Objectives Hierarchy

4. Sequence of Events
   Specifications of unifying theories or ideas which integrate or coordinate lesson segments and help achieve smooth transition and student flow.

5. For each Objective (Segment)
   * a. Objective Type (memory, concept, rule, problem solving, familiarization, psychomotor)
   * b. Instructional Method/Media to be used
   * c. General Statement of what is to be learned (e.g. Concept definition or rule statement)
   * d. Sample set of instances (1 for each type)
   e. Algorithm for concept identification or rule, application
   * f. Example Specification (type, range, number)
   g. Special Teaching Points (critical content considerations)
   * h. Strategy Specifications
   i. Graphic Specifications
   * j. Testing Specifications
      (1) Need for and placement of tests and practice items.
      (2) Test type

*These items must be included in all lesson specification documents. Other items may be included at discretion of the subject matter expert (SME) or instructional psychologist (IP).

Figure B-9. Format for Lesson Specification Document

strategy and lesson specification will also await the results of the development and training phases for full validation.

Training of Navy Subject Matter Experts

The procedures used in each of the steps of the ISD model are well defined and somewhat exacting. The terms and underlying con-

cepts are not within the experience of most subject matter experts. Therefore, the need arises to train subject matter experts to use the particular procedures specified.

To meet this need the Contractor is planning to conduct three formal training courses. (The first of these courses has been held already. Its purpose was, first, to give all SME a detailed overview of ISD. The second purpose of the course was to give the SME detailed training on how to perform a task listing. This training session took five days. The training schedule for this course is shown in Figure B-10.)

The second course to be given will train SME to develop objectives hierarchies. It will specifically address the topics of writing complete performance objectives, and will train them to use the hierarchy development algorithm used by the Contractor. This training course is scheduled to last approximately four days, and will begin 7 July 1975.

The third training course will train the SME to develop Lesson Specifications. In order to train this skill, prerequisite topics will also have to be addressed. These are topics such as writing general statements, examples, and practice items; determining type of testing, and so forth. This course is scheduled to last approximately four days. It will begin on 17 November 1975.

It is expected that these three courses will fulfill the training requirement of the SME. Of course, on-the-job training sessions will be held whenever a problem arises or a new task is being started.

INTRODUCTORY COURSE TO THE SYSTEMATIC APPROACH TO INSTRUCTIONAL DEVELOPMENT

MONDAY

8:30	Course Introduction
9:00	Assumptions Underlying the Systematic Approach to Instructional Development
9:45	Break
10:00	A Closer Look at Concepts
11:30	Lunch
1:00	A Closer Look at Rules
1:45	Break
2:00	Job Analysis, Selecting Tasks for Training
2:45	Break
3:00	Behavioral Objectives, and Objectives Hierarchies

TUESDAY

8:30	Generalities, Examples, Practice, and Helps
9:15	Break
9:30	Strategy Planning I
10:15	Break
10:30	Strategy Planning II
11:30	Lunch
1:00	Method/Media Selection
1:45	Break
2:00	Course Sequencing and Division into Lessons
3:00	Break
3:15	Lesson Specification Documents

WEDNESDAY

8:30	Lesson Production
9:30	Break
9:45	Test Production
10:45	Break
11:00	Formative Evaluation
11:30	Lunch
1:00	Instructional Systems Management
1:45	Break
2:00	Questions and Answers

THURSDAY

8:30	Job Analysis, a Detailed Look
9:30	Break
9:45	Group Exercise
11:30	Lunch
1:00	Review and Critique
2:00	Break
2:15	Individual Exercise

FRIDAY

8:30	Review and Critique
9:30	Individual Assignments

Figure B-10. Training Schedule

Appendix C

Task List and Job Analysis Survey Data

This is an extract from the Job Analysis Document, Data Item 0003, Contract No. N61339-75-C-0100.

TASK	CONDITIONS	STANDARDS
I. Conduct an ECM Mission.		
A. Conduct mission planning.	Given target, all DIA/OPNAV publications, current EOB, AOB & NOB. Given Airwing & SOP's, EA-6B limitations & capabilities.	Complete, accurate
1. Recommend attack profile.	Given target, all DIA/OPNAV publications, current EOB, AOB & NOB. Given Airwing & SOP's, EA-6B limitations & capabilities.	Complete, accurate, to yield maximum effectiveness.
a. Determine strike force composition. From alpha strike leader.		
b. Recommend strike force route.	Given target & targeting information plus all the geographic characteristics of the area.	100%
2. Determine EOB.	Given all appropriate charts, publications, and target information. Given radar limitations and operating perimeters.	Identify all electronic threats and all electronic perimeters of threat radars.
a. Determine geographic operating area.	Given target, and all appropriate maps and charts.	100%
b. Construct a chart of the operating area.	Given construction material, attack profile, and geographic operating area.	100%
c. Plot the location of target.	Given target location.	Use standard chart production symbology, plot it in correct position.

TASK	CONDITIONS	STANDARDS
d. List the geographic coordinates and radar types.	Given appropriate AERA (EOB) and list of confirmed probable, unoccupied, and dummy sites.	All sites in actual area of operation. In correct position.
e. Determine the presence of any hostile naval units.	Given current naval order of battle. Given current operational intelligence concerning hostile ship movement.	100%
f. List naval radars and probable enemy operating areas, of interest to the mission.	Given appropriate NOB. Given operating areas.	100%
g. List the geographic location of all military airfields and the types of aircrafts located at each field.	Given current air order of battle.	List all operational bases within operating area with associated A/C. Identify all threat AERA's.
h. Plot the data obtained from NOB & AOB.	Given AOB, NOB, & EOB. Given DIA & OPNAV publications. Given plotting materials.	100%
i. Plot threat weapons envelopes.	Given appropriate DIA/NAV publications. Given plotting materials.	100%
j. Plot radar detection ranges.	Given DIA radar handbooks. Given geographic location of sites. Given plotting materials.	100%
k. Identify deficiencies in the mission planning publications used.	Given all DIA/OPNAV publications used for planning.	Identify in the areas of operations and limitations.
1. Correct any deficiencies in EOB by DIA/OPNAV publications used.	Given EOB planning operational intelligence reports.	Use appropriate symbology, and plot in correct position.

TASK	CONDITIONS	STANDARDS
3. Determine EA-6B tactics.	Given attack force flight profile, systems limitations and hardware limits. Given strike plan.	Maximize ECM effectiveness.
a. Determine EA-6B flight profile.	Given attack force flight profile, systems limitations and hardware limits. Given strike plan.	Maximize ECM effectiveness.
b. Determine ECM targets.	Given EOB, threat priorities, proposed attack and EA-6B flight profile.	Maximize ECM effectiveness.
c. Determine EA-6B TJS employment.	Given EOB, threat priorities, proposed attack and EA-6B flight profile.	Maximize ECM effectiveness.
d. Determine optimum EA-6B pod loading.	Given EOB, threat priorities, proposed attack and EA-6B flight profile.	Maximize effectiveness.
e. Determine AN/ALQ-92 employment.	Given AOB and GCI capability, jamming restrictions.	Maximize ECM effectiveness.
f. Determine DECM equipment employment.	Given EOB, proposed EA-6B flight profile, and weapons on board.	Maximize probability of surviving.
4. Determine conduct of the mission.	Given air plan, flight schedule, target information, EOB, Comm plan.	Maximize use of available assets.
a. Determine launch time and PIM.	Given air plan, flight schedule, and information from CIC.	100%

TASK	CONDITIONS	STANDARDS
b. Determine comm plan.	Given information provided by the strike leader. Given airwing and squadron standard operating procedures.	100%
c. Determine rendezvous coordinates.	Given information provided by the strike leader. Given airwing and squadron standard operating procedures.	100%
d. Determine CIT/TOT/COT.	Given route of flight and information provided by the strike leader.	100%
e. Determine recovery time and sequence.	Given air plan, flight schedule, and airwing/squadron operating procedure.	100%
f. Determine support forces.	Given task force operating plan and air plan.	Determine possible utilization of all assets.
B. Conduct brief.	Given mission planning.	Presented in concise, well ordered and understandable manner.
1. Participate in strike force brief.	Given pre-flight planning.	Receive required information, inform strike group of EA-6B capabilities.
a. Receive INTEL brief.	Given information presented by ship or squadron intelligence officer.	Extract all pertinent information pertaining to EA-6B.
b. Receive WX brief.	Given a qualified aerographer or meterologist.	100%

TASK	CONDITIONS	STANDARDS
c. Receive element brief.	Given designated element leaders.	Copy 100% of necessary information.
d. Conduct EA-6B element brief.	Given mission planning and required charts. Given all normal briefing aids.	Presented in a clear, understandable manner. Cover completely all phases of the mission.
1. Identify threats to strike force.	Given mission planning.	Presented in a clear, understandable manner. Cover completely all phases of the mission.
2. Identify threats to be countered.	Given mission planning.	Presented in a clear, understandable manner. Cover completely all phases of the mission.
3. Define EA-6B position and movement at all critical mission times.	Given strike force ingress route, and mission planning.	Presented in a clear, understandable manner. Cover completely all phases of the mission.
2. Conduct detailed EA-6B element brief.	Given squadron, airwing and ship standard operating procedures. Given operating constraints.	Presented in a clear, understandable manner. Cover completely all phases of the mission.
a. Receive aircraft assignment.	Given information that is provided by maintenance control.	100%
b. Review launch, rendezvous, and recovery evolution.	Given current airwing and ship SOP.	100%
3. Conduct individual aircrew briefing.	Given NATOPS, PCL, squadron SOP, mission planning, and ships comm. plan.	Clear, concise and fully covering all phases of the mission.

TASK	CONDITIONS	STANDARDS
a. Conduct safety of flight brief.	Given NATOPS manual pocket check list and squadron SOP.	Clear, concise and fully covering all phases of the mission.
1. Review standard pre-flight procedures.	Given NATOPS manual.	Clear, concise and fully covering all phases of the mission.
2. Review standard launch/recovery procedure.	Given airwing SOP, squadron SOP, and ship SOP.	Clear, concise and fully covering all phases of the mission.
b. Conduct weapon system employment brief.	Given mission planning.	Clear, concise and understandable.
1. Review TJS employment.	Given mission planning.	Clear, concise and understandable.
2. Review NAV procedures.	Given mission planning.	Clear, concise and understandable.
3. Review ALQ-92/ DECM plan.	Given mission planning and knowledge of operating directives of higher authority.	Clear, concise and understandable.
4. Conduct aircrew coordination brief.	Given mission planning.	Clear, concise and understandable.
c. Review SAR procedures.	Given Area brief, conducted by air intelligence officer and airwing SOP.	Clear, concise and understandable.

TASK	CONDITIONS	STANDARDS
d. Identify communications procedures.	Given applicable communication directives.	All frequencies to be used (100%).
1. Review comm. frequencies and sequences.	Given knowledge of applicable communication plans.	Clear, concise and understandable.
2. Identify secure voice nets.	Given ships comm. plan.	Clear, concise and understandable.
3. Receive appropriate authentication device.	Given squadron duty officer or C.M.C.O.	100%
4. Receive appropriate "card of the day."	Given squadron duty officer.	100%
5. Review special call signs.	Given mission planning.	Clear, concise and understandable.
e. Answer squadron "Question of the day."	Given squadron flight schedule or Pod.	100%
f. Receive updated PIM, departure, and marshall instructions.	Given information provided by ship's IOIC.	Copy 100%
C. Conduct pre-flight.	Given A/C, maintenance information.	Performed so as not to delay launch sequence. Identify and manage all non-routine situations.

TASK	CONDITIONS	STANDARDS
1. Inspect and don flight gear.	Given appropriate flight gear.	100%
2. Review VIDS cards.	Given all post VIDS cards, SOP, NATOPS, and maintenance publications.	Review minimum of past 10 flights.
3. Conduct physical pre-flight of airframe and cockpit.	Given mission designated A/C.	100% in less than 15 minutes.
4. Strap in.	Given A/C and properly doned flight gear.	5 minutes.
5. Set up cockpit prior to addition of power.	Given A/C ready for flight and PCL.	Less than 5 minutes.
a. ECMO #1 set up cockpit.	Given A/C and PCL.	Less than 5 minutes.
1. Check oxygen.	Given mission ready A/C, PCL.	100%
2. Ensure vent/air-cushion airflow is off.	Given mission ready A/C, PCL.	100%
3. Check KY-28 #1 and #2 off.	Given mission ready A/C, PCL.	100%

TASK	CONDITIONS	STANDARDS
4. Set up ICS control box.	Given mission ready A/C and PCL.	100%
5. Set up ICS and radio mixer panels.	Given mission ready A/C and PCL.	100%
6. Check ALQ-92 power switch off.	Given mission ready A/C and PCL.	100%
7. Program ALE-29.	Given mission ready A/C and PCL.	100%
8. Set up ALQ-92.	Given mission ready A/C and PCL.	100%
9. Set up radar control panel.	Given mission ready A/C and PCL.	100%
10. Set up Doppler.	Given mission ready A/C and PCL.	100%
11. Ensure computer off.	Given mission ready A/C and PCL.	100%
12. Place TACAN to off.	Given mission ready A/C and PCL.	100%

TASK	CONDITIONS	STANDARDS
13. Ensure UHF #1 off.	Given mission ready A/C and PCL.	100%
14. Set up the IFF control panel.	Given mission ready A/C and PCL.	100%
15. Ensure defog off.	Given mission ready A/C and PCL.	100%
16. Ensure engine anti-ice off.	Given mission ready A/C and PCL.	100%
17. Ensure PITOT heat off.	Given mission ready A/C and PCL.	100%
18. Ensure wind-shield air oft.	Given mission ready A/C and PCL.	100%
19. Ensure UHF #2 off.	Given mission ready A/C and PCL.	100%
20. Ensure cabin dump-off.	Given mission ready A/C and PCL.	100%
21. Check air con-ditioning panel.	Given mission ready A/C and PCL.	100%

TASK	CONDITIONS	STANDARDS
b. Pilot set up cockpit.	Given mission ready A/C and PCL.	Completed in less than 5 minutes.
1. Verify Sel stores Jett SW - off.	Given mission ready A/C and PCL.	100%
2. Switch OXY SW-on and check.	Given mission ready A/C and PCL.	100%
3. Set up master light panel.	Given mission ready A/C and PCL.	100%
4. Verify hook bypass SW.	Given mission ready A/C and PCL.	100%
5. Verify Anti-skid SW off.	Given mission ready A/C and PCL.	100%
6. Verify Flapper on Pop-up SW off.	Given mission ready A/C and PCL.	100%
7. Verify Eject alarm SW off.	Given mission ready A/C and PCL.	100%
8. Verify Emerg. flap SW off.	Given mission ready A/C and PCL.	100%

TASK	CONDITIONS	STANDARDS
9. Verify throttles off.	Given mission ready A/C and PCL.	100%
10. Verify normal flap handle - up.	Given mission ready A/C and PCL.	100%
11. Verify Assist spin recovery SW-off.	Given mission ready A/C and PCL.	100%
12. Verify catapult rip - down and stowed.	Given mission ready A/C and PCL.	100%
13. Check bleed air switches - all on.	Given mission ready A/C and PCL.	100%
14. Set up fuel management panel.	Given mission ready A/C and PCL.	100%
15. Check parking brake handle - out.	Given mission ready A/C and PCL.	100%
16. Verify gear handle - down position.	Given mission ready A/C and PCL.	100%
17. Verify radar altimeter - off.	Given mission ready A/C and PCL.	100%

TASK	CONDITIONS	STANDARDS
18. Turn PHD brightness control full counterclockwise.	Given mission ready A/C and PCL.	100%
19. Check AUX brake gauge.	Given mission ready A/C and PCL.	100%
20. Reset accelerometer.	Given mission ready A/C and PCL.	100%
21. Wind & set clock.	Given mission ready A/C and PCL.	100%
22. Set vert ref SW - pri.	Given mission ready A/C and PCL.	100%
23. Rotate PHD azimuth/contrast controls full counterclockwise.	Given mission ready A/C and PCL.	100%
24. Set up DECM panel.	Given mission ready A/C and PCL.	100%
25. Switch both L & R Gen. SW - on.	Given mission ready A/C and PCL.	100%
26. Ensure engine & fuel master SW - off.	Given mission ready A/C and PCL.	100%

TASK	CONDITIONS	STANDARDS
27. Check canopy press. Gauge - normal.	Given mission ready A/C and PCL.	100%
28. Check Auto-pilot SW - off.	Given mission ready A/C and PCL.	100%
29. Verify #1 UHF-off.	Given mission ready A/C and PCL.	100%
30. Verify IFF control box - set for test.	Given mission ready A/C and PCL.	100%
31. Set up radio mixer panel - as desired.	Given mission ready A/C and PCL.	100%
32. Set up ICS mixer panel - as desired.	Given mission ready A/C and PCL.	100%
33. Set up ICS mixer control box.	Given mission ready A/C and PCL.	100%
34. Check pitot heat switch - off.	Given mission ready A/C and PCL.	100%
35. Check wind-shield air - off.	Given mission ready A/C and PCL.	100%

TASK	CONDITIONS	STANDARDS
3. Check oxygen.	Given mission ready A/C and PCL.	100%
4. Set up ICS control box.	Given mission ready A/C and PCL.	100%
5. Set up ICS and radio mixer panel.	Given mission ready A/C and PCL.	100%
6. Adjust video-scope.	Given mission ready A/C and PCL.	100%
7. Remove canopy safety pin.	Given mission ready A/C and PCL.	100%
6. Pilot initiate power application to the A/C.	Given A/C with cockpit properly set up and ground support personnel.	100%
7. All crew members check ICS.	Given A/C with electric power applied.	100%
8. Check EJECT alarm light in rear cockpit.	Given A/C with electric power applied.	100%
9. Pilot/ECMO-1 perform PCL prestart/start procedures.	Given A/C with external power applied and PCL.	Complete within 5 minutes - in proper sequence.

TASK	CONDITIONS	STANDARDS
36. Check defog airflow control - off.	Given mission ready A/C and PCL.	100%
37. Verify engine anti-ice - off.	Given mission ready A/C and PCL.	100%
38. Ensure ASN 50 is in slaved position and Lat. is set.	Given mission ready A/C and PCL.	100%
39. Verify cabin dump switch - off.	Given mission ready A/C and PCL.	100%
40. Set up air conditioning panel.	Given mission ready A/C and PCL.	100%
41. Remove canopy safety pin and close canopy.	Given mission ready A/C and PCL.	100%
c. ECMO - 2/3 set up cockpit.	Given cockpit simulator, aircraft, and PCL.	Complete in less than 5 minutes. All discrepancies corrected.
1. Ensure all circuit breakers are in.	Given cockpit simulator, aircraft, and PCL.	100%
2. Ensure vent/cushion airflow is off.	Given cockpit simulator, aircraft, and PCL.	100%

TASK	CONDITIONS	STANDARDS
10. Initialize systems.	Given an A/C or WST on internal power and a PCL.	1. Complete all items with verification. 2. Less than 15 minutes. 3. Mnge. non-routine situations.
a. Initialize ECMO-1 systems.	Given an A/C or WST on internal power and a PCL.	1. Complete all items with verification. 2. Less than 15 minutes. 3. Manage non-routine situations.
1. Turn on computer.	Given an A/C or WST on internal power and a PCL.	100%
2. Turn radar power to STBY.	Given an A/C or WST on internal power and a PCL.	100%
3. Turn on doppler power to STBY, warm-up 5 min., initiate doppler test.	Given an A/C or WST on internal power and a PCL.	100%
4. Bring communications equipment on.	Given an A/C or WST on internal power and a PCL.	100%
a. Turn on KY-28.	Given an A/C or WST on internal power and a PCL.	100%
5. Turn DECM master power switch to power.	Given A/C with external power applied and PCL.	100%
6. Insert NAV data.	Given mission planning A/C.	100%

TASK	CONDITIONS	STANDARDS
7. Place IFF switch in STBY.	Given A/C with external power applied.	100%
b. Initialize pilot systems.	Given A/C with external power applied and PCL.	Complete all items with verification. Less than 15 min. Manage all non routine situations.
1. Perform ASN-50 functional check.	Given A/C with external power applied and PCL.	100%
2. Perform DEFOG test.	Given A/C with external power applied and PCL.	100%
3. Perform wind-shield AIR/WASH test.	Given A/C with external power applied and PCL.	100%
4. Turn on auto pilot.	Given A/C with external power applied and PCL.	100%
5. Check oil quantity (light).	Given A/C on internal systems and PCL.	100%
6. Set altimeter.	Given A/C on internal systems and PCL.	100%
7. Turn on radar altimeter.	Given A/C on internal systems and PCL.	100%

TASK	CONDITIONS	STANDARDS
8. Perform fuel boost pump check.	Given A/C on internal systems and PCL.	1. Classify test results. 2. Manage all non-routine situations.
9. Perform bleed air shut-off valve check.	Given A/C on internal systems and PCL.	1. Classify test results. 2. Manage all non-routine situations.
c. Initialize ECMO-2/3 systems.	Given A/C on internal systems and PCL.	1. Complete all items with verification. 2. Less than 15 minutes. 3. Manage all non-routine situations.
1. Instruct ECMO-1 to turn on master power.	Given A/C on internal systems and PCL.	100%
2. Select STBY and set altimeter.	Given A/C on internal systems and PCL.	100%
3. Initiate master test.	Given A/C on internal power and PCL.	100%
4. Set interior lighting.	Given A/C on internal power and PCL.	100%
5. Obtain correct time.	Given A/C on internal power and PCL.	100%
1. Perform pretaxi procedures.	Given mission ready A/C on internal systems.	1. Perform entire procedure so as not to delay launch sequence. 2. Manage all non-routine situations.

TASK	CONDITIONS	STANDARDS
D. LAUNCH 1. Pilot/ECMO-1 taxi for T.O. carrier-based.	Given A/C ready for taxi/T.O.	1. Perform entire procedure so as not to delay launch. 2. Manage all non-routine situations.
a. Identify and respond to airframe system malfunction.	Given A/C on internal systems.	1. Accurately identify and respond to all non-routine situations. 2. Identify all system malfunctions in a timely manner so as to minimize system damage.
2. Taxi for T/O (shore-based).	Given A/C on internal systems ready for taxi/T.O.	1. Perform entire procedure so as not to delay launch. 2. Manage all non-routine situations.
3. PERFORM before take-off checklist (shore-based).	Given mission ready A/C on internal systems.	1. Execute complete checklist in an expeditious manner. 2. Respond to each item on the checklist. 3. Manage all non-routine situations.
4. TAKE-OFF (shore-based).	Given A/C ready for flight, PCL, and NATOPS.	Smooth-positive 100%.
a. Identify and respond to any aircraft system malfunction.	Given A/C in take-off phase, PCL, NATOPS, and SOP.	Perform all steps in sequence. Maintain control of A/C at all times.
5. Pilot-ECMO-1 execute after T/O procedure.	Given A/C airborne after flight isolate has been actuated, PCL, NATOPS, and SOP.	1. Manage all non-verify situations. 2. Complete all steps of procedure.
a. Turn on radar.	Given A/C airborne after flight isolate has been actuated, PCL, NATOPS, and SOP.	Manage all non-verify conditions. Complete actuation procedure in proper sequence.
b. Turn ALQ-92 - on.	Given A/C airborne after flight isolate has been actuated, PCL, NATOPS, and SOP.	100%

TASK	CONDITIONS	STANDARDS
c. Verify proper cabin pressure.	Given A/C airborne after flight isolate has been actuated, PCL, NATOPS, and SOP.	Identify proper readings (±) 500 ft.
d. Place altimeter to reset and reset Kollsman window.	Given A/C airborne after flight isolate has been actuated, PCL, NATOPS, and SOP.	100%
e. Verify fuel transfer.	Given A/C airborne after actuated, PCL, NATOPS, and SOP.	100%
f. Identify and respond to any aircraft system malfunction.	Given A/C during climb out phase PCL, NATOPS, and SOP.	1. Conform to NATOPS/PCL. 2. Perform all steps in proper sequence.
6. ECMO-2/3 execute after T/O procedure.	Given mission configured A/C just airborne, NATOPS, PCL, SOP.	1. Complete in sequence. 2. Conform to NATOPS/PCL and SOPs.
a. Select STBY and pod control box.	Given mission configured A/C just airborne, NATOPS, PCL, SOP.	100%
b. Perform pod radiate and control checks.	Given mission configured A/C just airborne, NATOPS, PCL, SOP.	1. Manage all non-routine situations. 2. Perform in proper sequence. 3. Identify all non-verify situations.
E. Conduct mission.	Given a properly configured, mission ready aircraft/pods. Mission planning.	Meet all threats within the capabilities of the aircraft.
1. Monitor and respond to appropriate communications throughout mission.	Given mission configured aircraft, mission planning, EMCON plan ship SOP, or Airwing SOP.	1. Comply to EMCON plan. 2. Initiating all neccessary messages. 3. Correctly responding to all comm.

TASK	CONDITIONS	STANDARDS
2. Pilot/ECMO-1 execute departure procedures.	Given A/C climbing after flight Isolate SW-isolated. Given departure instructions and clearance limits. Given PCL, NATOPS, and SOPs.	Comply to clearance limits $\pm$200 ft. $\pm 10^{\circ}$ $\pm$10 kts. Perform in sequence.
3. Pilot-ECMO-1 rendezvous as briefed.	Given RDV RAD/DME and ALT Given A/C and mission planning.	Expeditiously, safely, and without any undue delay.
4. Pilot/ECMO-1 proceed to predetermined points.	Given A/C in flight and mission planning.	$\pm$2 miles of track and turn point. $\pm$1 mile of target. Manage all degraded NAV situations/ equipment.
a. Update NAV solution.	Given functioning NAV system and mission planning.	Identify check points. Manage system malfunctions.
b. Crosscheck NAV solution.	Given functioning NAV system and mission planning.	Identify system malfunctions. Correct all non-routine readings.
c. Maintain strike force integrity.	Given mission planning, A/C in flight and strike group.	Maintain position $\pm$200 ft. $\pm$1 mile.
5. ECMO-2/3 turn on master radiate switch.	Given A/C.	100%
6. ECMO-2/3 monitor TJS.	Given operator DDI and video scope.	To accurately analyze electronic spectrum of operating area.
a. Observe F/S operation.	Given operable DDI and video scope.	To accurately and completely analyze system operation.

TASK	CONDITIONS	STANDARDS
b. Identify threat emitters.	Given DDI indications pre-flight planning.	Identify all emitters within list parameters.
c. Implement pre-determined optimum modulation assignments.	Given fully operating pod and system, mission planning.	1. Correctly implement the pre-planned mission. 2. In 1 min. of execution point. 3. Within 1 min. of system indication of non-optimal jamming modify ineffective jam-modular to maximize sys. eff.
d. Confirm POD antenna directions.	Given DDI and BDHI steerable antenna.	1. $\pm 1^{o}$ 15 seconds.
e. Confirm POD radiate power is within operating parameters.	Given optimal jamming operating master mode control box.	1. For each band identity limits $\pm$5DB.
f. Confirm POD radiate frequencies and spot-width are as assigned.	Given fully operable system.	1. 100% W/I the jamming parameter.
g. Identify and log appropriate data.	Given jamming data (time, frequency, and bearing).	1. Accurately record for specified signals as briefed.
h. Ensure A/C position is correct.	Given DDI and computer (NAV display) and back-up NAV system.	1. Confirm $\pm$3-5 miles.
i. Identify and respond to system failures.	Given PCL, SOPs, and appropriate trouble-shooting area.	1. Accurately and completely diagnose problem. 2. Apply all corrective procedures. 3. Record data for brief.
7. Respond to hostile threats by enemy.	Given EA-6B weapons in hostile environment.	1. Respond smoothly showing great cunning with imagination, skill, and daring.

TASK	CONDITIONS	STANDARDS
8. Pilot/ECMO-1 initiate predetermined DECM plan.	Given operable DECM package, airwing, and squadron SOPs.	100%
a. Dispense chaff.	Given tactical situation in hostile environment. Operable DECM package.	Timely - 70 maximize the systems effectiveness.
9. Employ ALQ-92.		
10. ECMO-2/3 secure ECM activity.	Given completed ECM mission.	100%
11. Conduct fault isolation.	Given PCL, SOP, and appropriate T/S aids.	Conduct and completely diagnose problem. Apply all correct procedures. Record results for later debrief.
a. Identify and record all system malfunctions.	Given PCL, SOP, and a subject malfunction.	Identify all system malfunctions. Record all non-verify indications.
1. Conduct OBS bit.	Given PCL, SOP, and functioning system.	Proper procedure. Manage all non-verify indications. Record all non-routine.
2. Conduct POD bit.	Given functioning system, PCL, and SOPs.	Proper procedure. Manage all non-verify indications. Record all non-routine.

TASK	CONDITIONS	STANDARDS
3. Perform spot monitor checks.	Given functioning system, PCL, and SOPs.	Proper procedure. Manage all non-verify indications. Record all non-routine.
F. RECOVERY	Given A/C in flight.	1. Manage all non-routine situations. 2. Identify all unsafe conditions. 3. Perform satisfactorily. Approximately 100%.
1. Pilot/ECMO-1 proceed to recovery area.	Given A/C in flight and recovery instructions/clearance.	1. Manage all non-routine situations. 2. ± 50 ft. ± 10° ± 15 kts.
2. Pilot/ECMO-1 execute shipboard recovery procedure.	Given marshall instructions/clearance	1. Smooth. 2. ± 10° leading ± 10 kts.
a. Execute Case 3 recovery.	Given Case 3 weather conditions as dictated by ships SOP, NATOPS, and airwing SOP.	± 100 ft. during ± 10° ± 10 kts. On final ± 50 ft. ± 5° ± 5 kts.
b. Execute Case 2 recovery.	Given Case 2 weather conditions, as dictated by . . .	± 100 ft. during ± 10° ± 10 kts. On final ± 50 ft. ± 5 ± 5 kts.
c. Execute Case 1 recovery.	Given Case 1 weather conditions, as dictated by . . .	± 100 ft. during ± 10° ± 10 kts. On final ± 50 ft. ± 5 ± 5 kts.
3. Pilot/ECMO-1 execute shore-based recovery.	Given A/C in flight.	1. Manage all non-routine situations. 2. Identify all unsafe conditions. 3. Comply with clearance limits.
a. Execute a VFR recovery and landing.	Given A/C in flight. Given penetration/approach clearance.	1. Satisfactorily land 100% of the time. Penetration ± 200 ft. ± 10° ± 15 kts. ± 100 ft. ± 5° ± 5 kts.

TASK	CONDITIONS	STANDARDS
b. Perform a Tacan recovery and landing.	Given A/C in flight. Given penetration/approach. Clearance and Tacan approach plate.	1. Satisfactorily land 100% of the time. Penetration $\pm$200 ft. $\pm 10^{o}$ $\pm$15kts. $\pm$100 ft. $\pm 5^{o}$ $\pm$5 kts.
c. Perform an enroute precision recovery and landing.	Given A/C in flight. Given clearance and radio comm.	1. Satisfactorily land 100% of the time. Penetration $\pm$200 ft. $\pm 10^{o}$ $\pm$15 kts. $\pm$100 ft. $\pm 5^{o}$ $\pm$5 kts.
G. Perform postflight procedures.	Given A/C, NATOPS, PCL, and checklists.	1. Identify all abnormal conditions. 2. Perform complete postflight procedure/checklist in proper sequence.
1. Perform shore-based postflight procedures.	Given A/C after a shore-based landing NATOPS/PCL and checklist.	1. Identify all abnormal conditions. 2. Perform complete postflight procedure/checklist in proper sequence. Brief maintenance person on all non-standard conditions.
a. Perform airframe postflight inspection	Given A/C after engine has been shut down.	1. Identify all abnormal conditions. 2. Perform complete postflight procedure/checklist in proper sequence. Brief maintenance person on all non-standard conditions.
2. Perform carrier-based postflight procedures.	Given A/C just after arrestment and clear of landing area.	1. Identify all abnormal conditions. 2. Perform complete postflight procedure/checklist in proper sequence. Brief maintenance person on all non-standard conditions.
3. Conduct maintenance debrief.	Given pertinent maintenance information recorded during the mission verified by gauge readings, built-in test or other valid trouble shooting procedures.	1. Communicate gripes in a fully understandable manner. 2. Identify actual discrepancy.
1. Debrief A/F system.	Given pertinent maintenance information recorded during the mission verified by gauge readings, built-in test or other valid trouble shooting procedures.	100%
2. Debrief NAV/COMM systems.	Given pertinent maintenance information recorded during the mission verified by gauge readings, built-in test or other valid trouble shooting procedures.	100%

TASK	CONDITIONS	STANDARDS
3. Debrief DECM/ RHAW.	Given pertinent maintenance information recorded during the mission verified by gauge readings, built-in test or other valid trouble-shooting procedures.	100%
4. Debrief ALQ-92	Given pertinent maintenance information recorded during the mission verified by gauge readings, built-in test or other valid trouble-shooting procedures.	100%
5. Debrief life support systems.	Given pertinent maintenance information recorded during the mission verified by gauge readings, built-in test or other valid trouble-shooting procedures.	100%
6. Debrief OBS.	Given pertinent maintenance information recorded during the mission verified by gauge readings, built-in test or other valid trouble-shooting procedures.	100%
7. Debrief PODS.	Given pertinent maintenance information recorded during the mission verified by gauge readings, built-in test or other valid trouble-shooting procedures.	100%
a. Fill out and sign VIDS cards.	Given pertinent maintenance discrepancies. Given VIDS cards.	Complete in a manner so as to communicate actual problem.
b. Fill out and sign yellow sheet.	Given pertinent time, numbers, and other information. Given yellow sheet.	Completely fill out with proper information in all the blocks.
H. Conduct mission debrief.	Given mission data and all required forms.	Accurately communicate the information concerning the previous flight.
1. Conduct intelligence debrief.	Given mission data and all required forms.	Accurate, to satisfy appropriate requirements.

TASK	CONDITIONS	STANDARDS
a. Complete OPREP-4.	Given OPREP form and mission data.	Accurate and in proper format.
b. Conduct general intelligence debrief.	Given mission data.	100%
2. Conduct strike force debrief.	Given mission data and ECM log.	Accurately communicate all significant mission data.
3. Receive LSO comments.	Given LSO.	Receive comments.

Appendix D

Sample EA-6B Objectives Hierarchies

USE OF THIS DOCUMENT

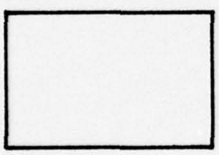
In systematic approaches to instructional development a universal first step is to determine what must be learned. This document contains the results of an analytic process to determine such for the training of EA-6B aircrewmen. It was arrived at in two states:

1. analysis of the jobs to be performed into component duties and tasks, providing a set of terminal tasks for training to work toward, and

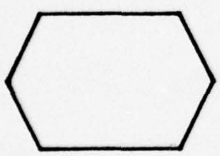
2. hierarchical analysis of each task to determine intermediate learning requirements needed by the learner to proceed smoothly to those terminal tasks.

The results of this analysis is the following set of hierarchies. A terminal objective is shown being broken down into supporting objectives. Hierarchies are shown in their relation to one another by numbered boxes. The content of each box is one objective, referenced by the box number.

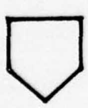
The results of this analysis is the following set of hierarchies. The symbols below are defined to facilitate use of this document.



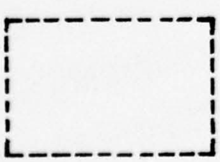
= This refers to an objective statement.



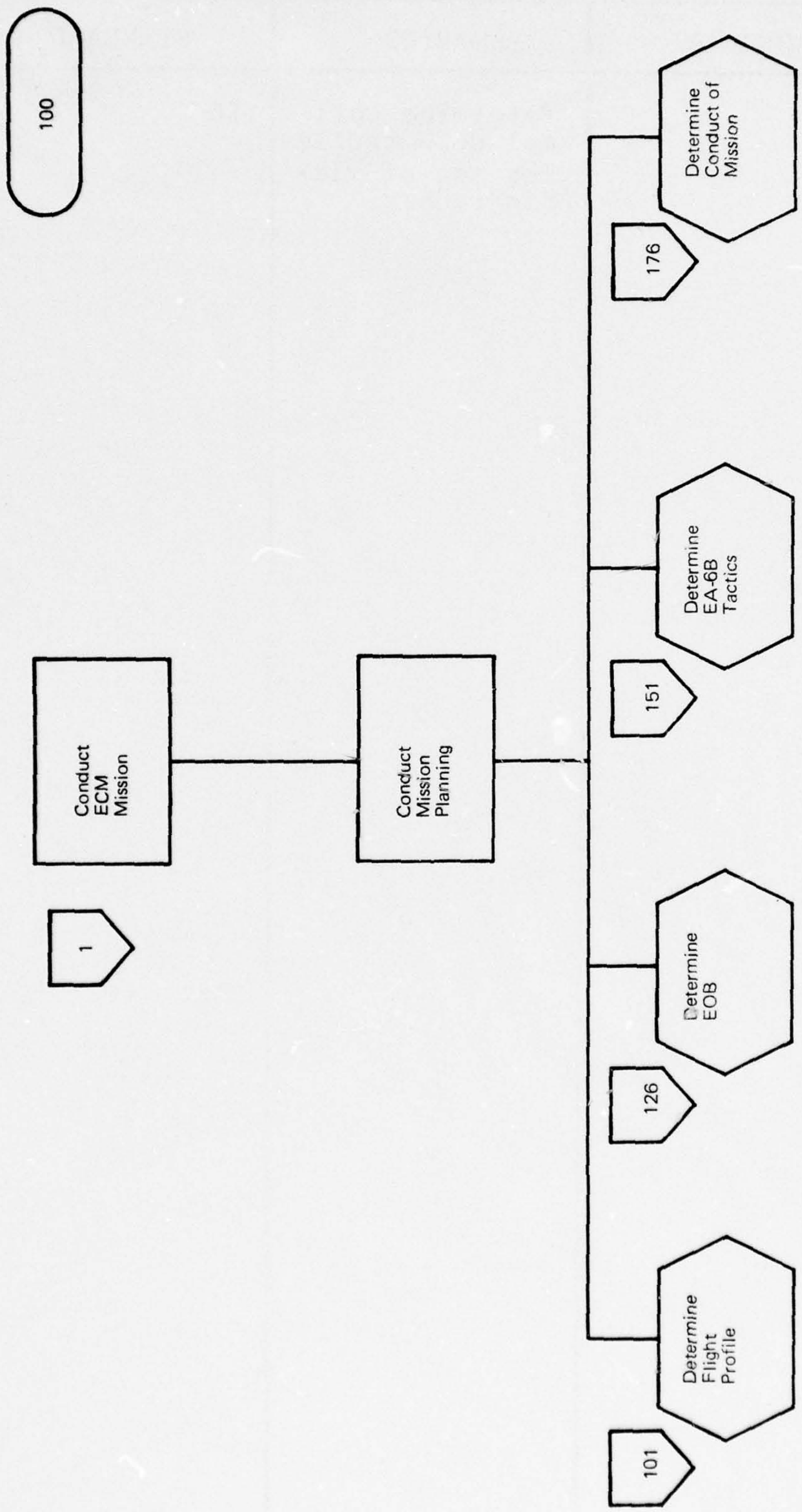
= This refers to objectives of similar content but found on different pages.



= This refers by number to related objectives in other hierarchies and provides either the objective or hierarchy number or both.



= Refers to the next higher set of hierarchies of which this is a part.


100
Conduct ECM Mission
1
Conduct Mission Planning
Determine Flight Profile
101
Determine EOB
126
Determine EA-6B Tactics
151
Determine Conduct of Mission
176

OBJECTIVES FOR HIERARCHY #151

OBJ. #	CONDITIONS	BEHAVIOR	STANDARD
24		Determine optimal DECM tactics for set of victim radars.	156

OBJECTIVES FOR HIERARCHY #151

<table>
<tr><th>OBJ. #</th><th>CONDITIONS</th><th>BEHAVIOR</th><th>STANDARD</th></tr>
<tr><td>13</td><td></td><td>State indicators of target tracking radar.</td><td rowspan="4">Stating all para., i.e., PW. PRF. RF.

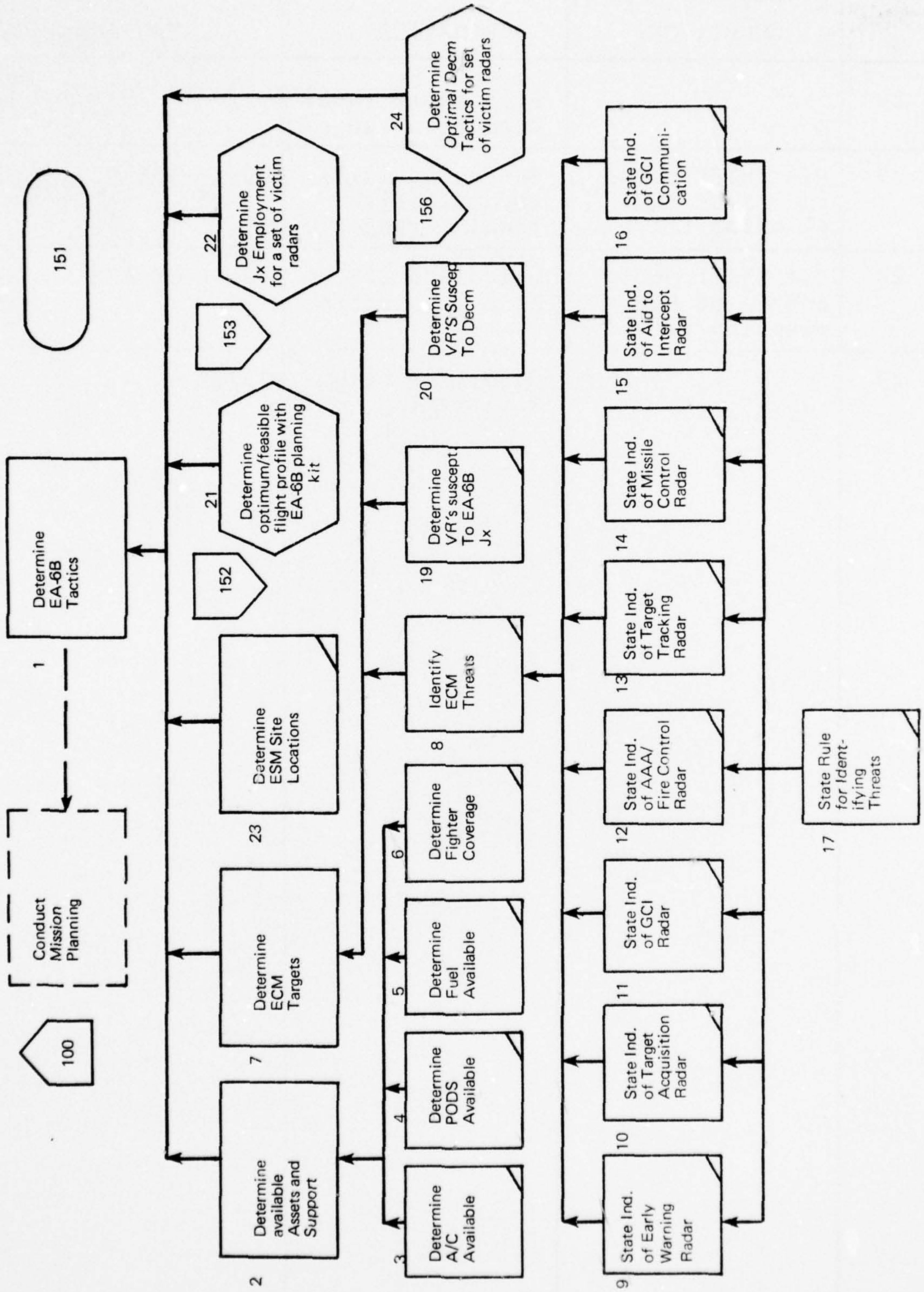
Scan rate and type in general terms.

State each radar specific characteristics.

State the rule for classifying each radar.</td></tr>
<tr><td>14</td><td></td><td>State indicators of missile control radar.</td></tr>
<tr><td>15</td><td></td><td>State indicators of aid to intercept radar.</td></tr>
<tr><td>16</td><td></td><td>State indicators of GCI communication.</td></tr>
<tr><td>17</td><td></td><td>State rule for identifying threats.</td><td>100%</td></tr>
<tr><td>18</td><td></td><td></td><td></td></tr>
<tr><td>19</td><td>Victim radar & appropriate DIA INTEL pubs.</td><td>Determine victim radar's susceptibility to EA-6B jamming.</td><td></td></tr>
<tr><td>20</td><td>Victim radar & appropriate DIA INTEL pubs.</td><td>Determine victim radar's susceptibility to DECM.</td><td></td></tr>
<tr><td>21</td><td></td><td>Determine optimum/feasible flight profile with EA-6B planning kit.</td><td>152</td></tr>
<tr><td>22</td><td></td><td>Determine Jx employment for a set of victim radars.</td><td>153</td></tr>
<tr><td>23</td><td></td><td>Determine ECM site location.</td><td></td></tr>
</table>

OBJECTIVES FOR HIERARCHY #151

OBJ. #	CONDITIONS	BEHAVIOR	STANDARD
1	Attack profile, EOB, DIA INTEL publications, info. from M/C.	Determine EA-6B tactics.	To maximize ECM effectiveness according to APL calculations.
2	Information from M/C.	Determine available assets and support.	100%
3	Information from M/C.	Determine A/C available.	100%
4	Information from M/C.	Determine pods available.	100%
5	Information from M/C.	Determine fuel available.	100%
6	Info from STK OPS/STK LDR air plan.	Determine fighter cover.	100%
7	Radar, appropriate DIA INTEL publications & EOB.	Determine ECM targets.	
8	Given a written description	Identify ECM threats.	Threat parameters - range.
9		State indicators of early warning radar.	Stating all para., i.e., PW. PRF. RF. Scan rate and type in general terms. State each radar specific characteristics. State the rule for classifying each radar.
10		State indicators of target acquisition radar.	
11		State indicators of ground control intercept radar.	
12		State indicators of triple A fire control radar.	


151
100
Conduct Mission Planning
1
Determine EA-6B Tactics
2
Determine available Assets and Support
7
Determine ECM Targets
23
Determine ESM Site Locations
152
21
Determine optimum/feasible flight profile with EA-6B planning kit
153
22
Determine Jx Employment for a set of victim radars
24
Determine Optimal Decm Tactics for set of victim radars
156
3
Determine A/C Available
4
Determine PODS Available
5
Determine Fuel Available
6
Determine Fighter Coverage
8
Identify ECM Threats
19
Determine VR's suscept. To EA-6B Jx
20
Determine VR'S Suscep To Decm
9
State Ind. of Early Warning Radar
10
State Ind. of Target Acquisition Radar
11
State Ind. of GCI Radar
12
State Ind. of AAA/ Fire Control Radar
13
State Ind. of Target Tracking Radar
14
State Ind. of Missile Control Radar
15
State Ind. of Aid to Intercept Radar
16
State Ind. of GCI Communi- cation
17
State Rule for Ident- ifying Threats

OBJECTIVES FOR HIERARCHY #152

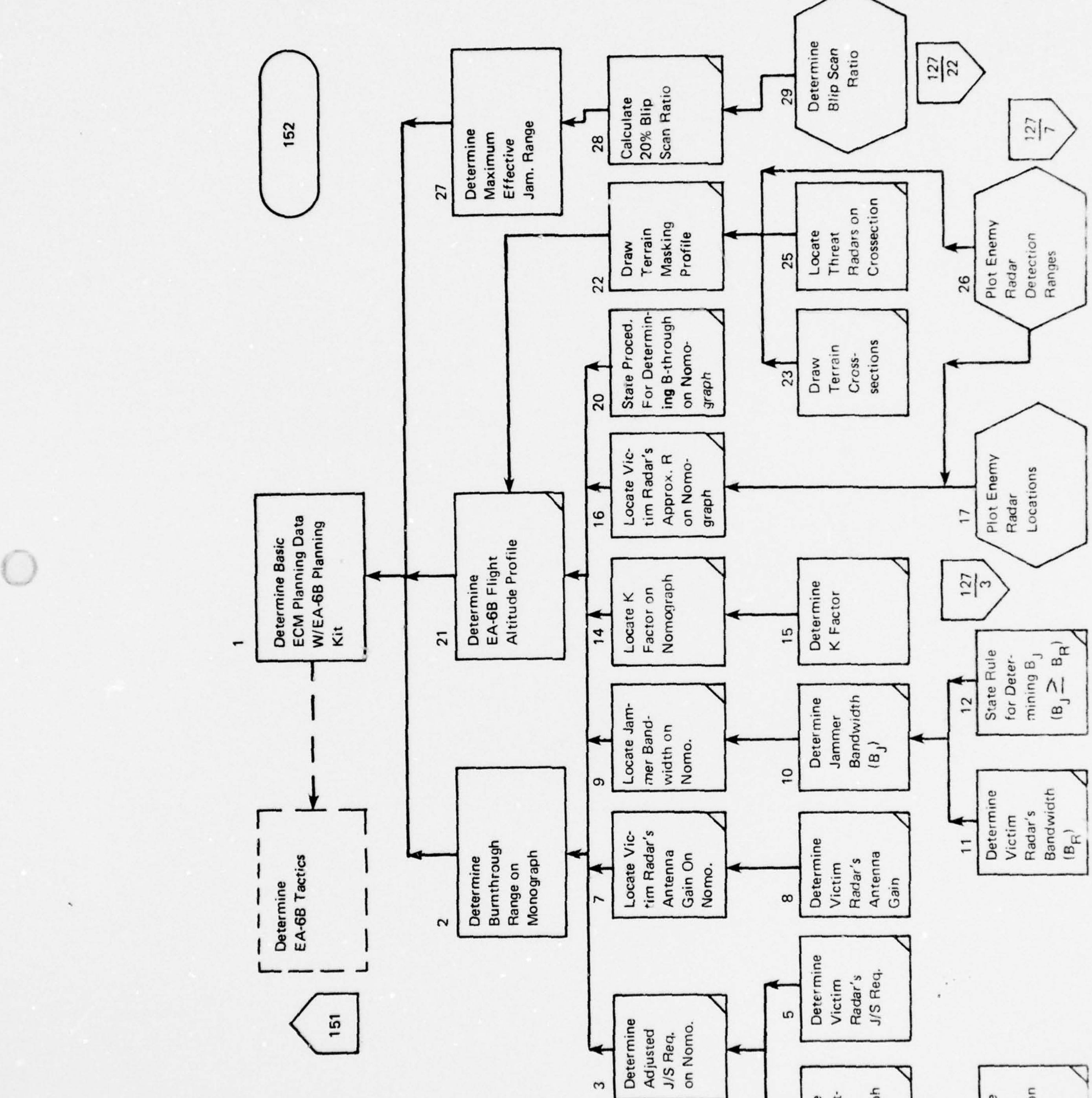
OBJ. #	CONDITIONS	BEHAVIOR	STANDARD
26		Plot enemy radar detection range.	127/7
27	DIA INTEL pubs. and EA-6B ECM planning kit.	Determine maximum effective jamming range.	100% $\pm$ 10% $R_{JX/Max}$
28	DIA INTEL pubs. and EA-6B ECM planning kit.	Calculate 20% blip scan ratio.	100% $\pm$ 1% BSR
29		Determine blip scan ratio.	127/22

OBJECTIVES FOR HIERARCHY #152

OBJ. #	CONDITIONS	BEHAVIOR	STANDARD
12		State rule for determining B_J ($B_J \leq B_R$).	100%
13			
14	Nomograph.	Locate K factor on nomograph.	100% $\pm$ nomograph accuracy.
15	DIA INTEL pubs. & EA-6B ECM planning kit.	Determine K factor.	100%
16	Nomograph.	Locate victim radar's approximate range on nomograph.	100% $\pm$ 5% Ruax
17		Plot enemy radar locations.	127/3
18			
19			
20		State procedure for determining burnthrough on nomograph.	100%
21	EA-6B planning kit & chart	Determine EA-6B flight altitude profile.	100% $\pm$ 1 NM, $\pm$ 100 ft.
22	EA-6B planning kit & chart	Draw terrain masking profile.	100% $\pm$ 100 ft.
23	EA-6B planning kit & chart	Draw terrain cross-section.	5 per radar 100% $\pm$ accuracy of chart
24	Topographical map.	Identify standard map symbols.	100% of elevation symbols
25		Locate threat radar's on cross-section.	100% $\pm$ 1 NM $\pm$ elev. accuracy of chart.

OBJECTIVES FOR HIERARCHY #152

OBJ. #	CONDITIONS	BEHAVIOR	STANDARD
1	Attack profile, EOB, DIA INTEL pubs., EA-6B planning kit.	Determine basic ECM planning data w/EA-6B planning kit.	
2		Determine burnth rough range on nomograph.	
3		Determine adjusted J/S required, on nomograph.	
4		Determine J/S adjustment on nomograph.	
5	DIA INTEL publications.	Determine victim radar's J/S required.	100%
6	DIA INTEL publications, radar EA-6B planning kit.	Determine target cross-section.	100% $\pm$ 5% σ
7	Nomograph.	Locate victim radar's antenna gain on nomograph.	100% $\pm$ nomograph accuracy
8	DIA INTEL publications, radar.	Determine victim radar's antenna gain to EA-6B.	100% $\pm$ 3db
9	Nomograph.	Locate jammer bandwidth on nomograph.	100% $\pm$ nomograph accuracy
10	DIA INTEL pubs.	Determine jammer bandwidth (B_J).	100%
11	DIA INTEL pubs.	Determine victim radar's bandwidth (B_R).	100%


152
1 Determine Basic ECM Planning Data W/EA-6B Planning Kit
Determine EA-6B Tactics
151
2 Determine Burnthrough Range on Monograph
21 Determine EA-6B Flight Altitude Profile
27 Determine Maximum Effective Jam. Range
28 Calculate 20% Blip Scan Ratio
29 Determine Blip Scan Ratio
127/22
127/7
22 Draw Terrain Masking Profile
25 Locate Threat Radars on Crossection
26 Plot Enemy Radar Detection Ranges
20 State Proced. For Determining B-through on Nomograph
23 Draw Terrain Cross-sections
16 Locate Victim Radar's Approx. R on Nomograph
17 Plot Enemy Radar Locations
14 Locate K Factor on Nomograph
15 Determine K Factor
127/3
9 Locate Jammer Bandwidth on Nomo.
10 Determine Jammer Bandwidth (B_J)
12 State Rule for Determining B_J ($B_J \geq B_R$)
11 Determine Victim Radar's Bandwidth (B_R)
7 Locate Victim Radar's Antenna Gain On Nomo.
8 Determine Victim Radar's Antenna Gain
3 Determine Adjusted J/S Req. on Nomo.
5 Determine Victim Radar's J/S Req.
4 Determine J/S Adjustment on Nomograph
6 Determine Target Crossection

Appendix E

Sample EA-6B Unit and Lesson Maps

Unit 14: Introduction EA-6B Aircraft Systems.

Lesson 10: Introduction to the Engine System.

Lesson 9: Introduction to the Fuel System.

Lesson 8: Introduction to the Electrical System.

Lesson 7: Introduction to the Hydraulic System.

Lesson 6: Introduction to the Environmental System.

Lesson 5: Introduction to the Pneumatic System.

Lesson 4: Introduction to the Aircraft Performance Indicators System.

Lesson 3: Introduction to the Weight-on-Wheels System.

Lesson 2: Introduction to the Ejection Seat System.

Lesson 1: Demonstration at NAMTRADET.

Unit 13: Aircraft Initialization.

Lesson 9: Physical Airframe and Cockpit Inspection.

Lesson 8: Flight Gear and Strap-in Procedures.

Lesson 7: Set-up Cockpit Prior to Power.

Lesson 6: Set-up Doppler, ICS, and IFF.

Lesson 5: Hand Signals.

Lesson 4: Prestart and Normal Start Procedures.

Lesson 3: Initialize Pilot Systems.

Lesson 2: Pretaxi/Taxi Procedure.

Lesson 1: Initialization, Start Trainer.

Unit 12: Communications.

Lesson 6: Communication Gear Operation.

Lesson 5: Two Way Voice Communications.

Lesson 4: Manage Communication Malfunctions.

Lesson 3: TACAN Navigation.

Lesson 2: TACAN Malfunctions.

Lesson 1: Communications/TACAN Navigation Trainer.

Unit 11: Take-off, Climb-out and Level-off Procedures.

Lesson 7: Pre-take-off Procedure.

Lesson 6: Take-off Engine Checks.

Lesson 5: Abort Procedures.

Lesson 4: Launch, Climb-out, and Level-off Procedures.

Lesson 3: After Launch Procedure.

Lesson 2: Ejection Procedures.

Lesson 1: Take-off, Climb-out and Level-off trainers.

Unit 10: Normal Penetrations, Approaches, and Landings.

Lesson 6: Approach and Landing Parameters.

Lesson 5: ADF and TACAN Penetrations.

Lesson 4: Approach and Landing Procedures.

Lesson 3: Missed Approaches.

Lesson 2: Post-flight Procedures.

Lesson 1: Penetration Approach and Landing Trainer.

Unit 9: Aircraft Malfunction.

Lesson 18: Engine Malfunctions.

Lesson 17: Airconditioning and Environmental System Malfunctions.

Lesson 16: Engine and Environmental Malfunctions Trainer.

Lesson 15: Electrical Malfunctions.

Lesson 14: Identify Hydraulic Malfunctions.

Lesson 13: Identify Hydraulic Operated Component Malfunctions.

Lesson 12: Respond to Hydraulic Malfunctions.

Lesson 11: Starting Malfunctions.

Lesson 10: Electrical, Hydraulic, and Starting Malfunctions Trainer.

Lesson 9: Fuel Malfunctions.

Lesson 8: Performance Indicators Malfunctions.

Lesson 7: TJS Malfunctions.

Lesson 6: Fuel and Performance Indicators and TJS Malfunctions Trainer.

Lesson 5: Situational Emergency Procedures.

Lesson 4: Excessive Angle-of-attack Emergencies.

Lesson 3: Manage Spins and Damaged Aircraft.

Lesson 2: Emergency Situations - Priorities.

Lesson 1: Malfunctions Trainer.

Unit 8: Navigation and Flight Planning.

Lesson 12: Navigation Computer Operation.

Lesson 11: Insert NAV Data.

Lesson 10: Response to Invalid CCI Readouts.

Lesson 9: Manage NAV Computer Malfunction.

Lesson 8: Dead Reckoning Navigation.

Lesson 7: Navigation Flight (Using Computer).

Lesson 6: Radar Operation.

Lesson 5: Interpret the Radar.

Lesson 4: Radar Navigation Trainer.

Lesson 3: Radar Turn Point Predictions.

Lesson 2: Radar Malfunctions.

Lesson 1: Radar Navigation Trainer and Flight.

Unit 7: Brief and Debrief.

Lesson 5: General Crew Briefing Responsbilities.

Lesson 4: Briefing Items.

Lesson 3: Review of VIDS Cards.

Lesson 2: Debriefing Items.

Lesson 1: Brief and Debrief Exercise.

Unit 6: Familiarization and Proficiency Flight.

Lesson 17: EA-6B Demonstration Flight.

Lesson 16: Basic Flight Maneuvers Flight.

Lesson 15: TACAN Penetration.

Lesson 14: Acrobatics.

Lesson 13: TACAN Navigation and Approaches.

Lesson 12: Precision Approach and Landings.

Lesson 11: Radar Navigation Flight 1.

Lesson 10: Day Formation and Tanking Flight.

Lesson 9: Day Formation and Tanking Flight.

Lesson 8: In Flight Refueling.

Lesson 7: Radar Navigation Flight 2.

Lesson 6: Low Level Navigation Flight 1.

Lesson 5: Night Time TACAN/Radar Navigation Flight.

Lesson 4: Night Formation Flight.

Lesson 3: Night Formation and Tanking Flight.

Lesson 2: Jammer Profile Flight.

Lesson 1: NATOPs Check Flight.

Unit 5: Carrier Qualifications.

Lesson 8: Carrier Recovery Procedures.

Lesson 7: Review of Recovery Communications.

Lesson 6: Waveoff and After Touchdown.

Lesson 5: Field Carrier Landing Practice.

Lesson 4: Shipboard Launch Procedures.

Lesson 3: Shipboard Operations.

Lesson 2: Catapult Shots and Traps.

Lesson 1: Carrier Controlled Approaches.

Unit 4: Tactical Jamming System Operation.

Lesson 15: TJS Familiarization.

Lesson 14: TJS Modes and Assignment Methods.

Lesson 13: DDI Operation (pt. 1).

Lesson 12: DDI Operation (pt. 2).

Lesson 11: Initialization Tableau.

Lesson 10: Frequency Azmith Tableau.

Lesson 9: Navigation Tableau.

Lesson 8: Alarms Tableau.

Lesson 7: List Tableau.

Lesson 6: Jammer Status Tableau.

Lesson 5: Bit Tableau.

Lesson 4: Signal Lists and Displays.

Lesson 3: Alarms Zone.

Lesson 2: Pulsewidth Stripping and Band 7 Attenuation.

Lesson 1: TJS Operations Trainer.

Unit 3: Radar Identification and Jammer Assignment.

Lesson 11: Radar Identification (pt. 1).

Lesson 10: Radar Identification (pt. 2).

Lesson 9: Radar Threats.

Lesson 8: Identify ECM Threats.

Lesson 7: Threats and Susceptability.

Lesson 6: Target Priorities.

Lesson 5: Effect of TJS Component Loss.

Lesson 4: Optimal Jammer Assignment.

Lesson 3: Jammer Asset Usage.

Lesson 2: Signal Identification.

Lesson 1: Jammer Operation Trainer.

Unit 2: Mission Planning

Lesson 7: General Operation Area.

Lesson 6: Plotting Enemy Order of Battle (pt. 1).

Lesson 5: Plotting Enemy Order of Battle (pt. 2).

Lesson 4: Plotting Enemy Order of Battle (pt. 3).

Lesson 3: Chart Construction.

Lesson 2: Crew Coordination.

Lesson 1: Crew Briefing.

Unit 1: Initialization Procedures.

Lesson 4: General Procedure to Set Up Right Front Cockpit.

Lesson 3: General Procedure to Set Up Rear Cockpit.

Lesson 2: POD Correct Procedures.

Lesson 1: Initialization and Degraded Systems Trainer.

AD-A035 616 COURSEWARE INC SAN DIEGO CALIF F/G 5/9

A STUDY OF THE EFFECTIVENESS, FEASIBILITY, AND RESOURCE REQUIRE--ETC(U)

JAN 77 J A HUGHES, J P HYMES N61339-75-C-0100

UNCLASSIFIED NAVTRAEQUIPC-75-C-0100-1 NL

3 OF 4

AD-A

035616

P. 14.9

INTRODUCTION TO THE FUEL SYSTEM

1. State the operating limitations of the fuel system.
   - s. Correctly state all fuel system designed maximum and/or minimum operational limitations as defined by NATOPs.

2. Locate the cockpit controls and indicators, and describe the operation of the fuel regulation and filtering systems.
   - c. Given a cockpit diagram and fuel system schematic.
   - s. Cover input pressure and source, component transaction or operation, cockpit indicator and control, and output of the:
     - A. Fuel filter and bypass
     - B. Engine fuel heater
     - C. Fuel oil cooler

3. Locate the cockpit controls and indicator, and describe the operation of the fuel pressure boosting system.
   - c. Given a cockpit diagram and a fuel system schematic.
   - s. Cover input pressure and source, component transaction or operation, cockpit indicator and control, and output of the:
     - A. Fuselage boost pump
     - B. Engine driven fuel pump.

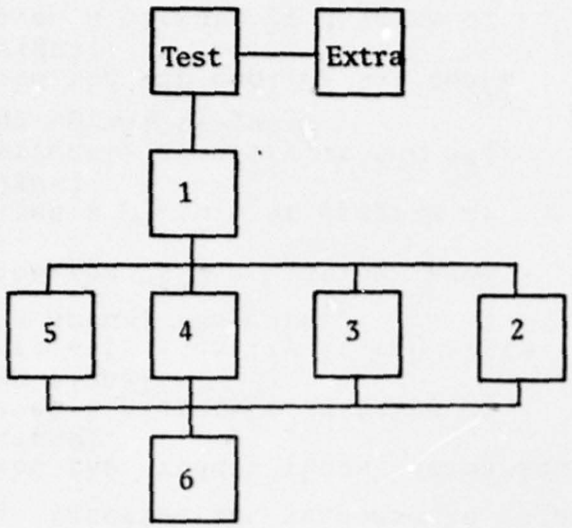
4. Locate the C.P. control and indicator and describe the operation of the fuel quantity indicator system.
   - c. Given a C.P. diagram and a fuel system schematic.
   - s. Cover input pressure and source, component transaction or operation, C.P. indicator and control, and output of the
     - A. Quantity gauge.
     - B. Low fuel warning system.

5. Locate the C.P. control and indicator and describe the operation of the fuel tank and dump system.
   - c. Given a C.P. diagram and a fuel system schematic.
   - s. Cover input pressure and source, component transaction or operation, C.P. indicator and control, and output of the:
     - A. Fuel pressure regulator
     - B. Transfer and refueling valve
     - C. Wing gate valves and fuselage dump valve

6. Describe the normal operation of the fuel system.
   - c. Given a schematic of the a/c fuel system and all related components.
   - s. State the names of the four fuel sub-systems and describe the function of each.

LS: Hierarchy Page

Course, Unit, Lesson: P. 14.9   Title: Introduction to the Fuel System



#	Topic	Media	Testing
1.	Operating limitations of the Fuel System.		M
2.	Controls, indicators, and operation of the fuel temperature regulation and filtering system.		M
3.	Controls, indicators, and operation of the fuel pressure boosting system.		M
4.	Controls, indicators, and operation of the fuel quantity indicating system.		M
5.	Controls, indicators, and operation of the fuel tank pressure and dump system.		M
6.	Normal operation of the fuel system.		M

The prerequisites to this lesson are:

This lesson is prerequisite to:

P. 13.5
PRE-START AND START HAND SIGNAL

1. Identify Navy standard pre-start and start hand signals.
   c. Given a picture or diagram of each hand signal.
   s. A. Correctly identify all hand signals.
      B. Describe the response to each.

2. Identify EA-6B specific pre-start and start hand signals.
   c. Given a picture or diagram of each hand signal.
   s. A. Correctly identify the hand signal and
      B. Describe the response to each.

3. Describe the "rudder throw" actuation hand signal.
   c. Given a picture or diagram of the signal.
   s. Correctly identify it and state the normal response.

4. Describe the "RAT operation" hand signal.
   c. Given a picture or diagram of the signal.
   s. Correctly identify it and state the normal response.

5. Describe the CSD cooling air check hand signal.
   c. Given a picture or diagram of the signal.
   s. Correctly identify it and state the normal response.

6. Describe the fuel tank pressurization actuation check hand signal.
   c. Given a picture or diagram of the signal.
   s. Correctly identify it and state the normal response.

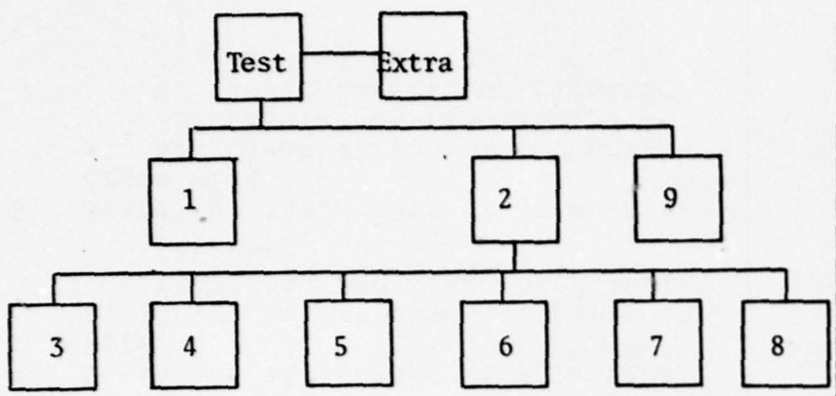
7. Describe the normal troubleshooting hand signal.
   c. Given a picture or diagram of the signal.
   s. Correctly identify the signal and state the normal response.

8. Describe the 20 degree flap signal.
   c. Given a picture or diagram of the signal.
   s. Correctly identify the signal and state the normal response.

9. Identify Navy standard aircraft hand signals.
   c. Given a written description or picture of each hand signal.
   s. 100% correctly identify the following groups of hand signals.
      A. Taxi/launch.
      B. Mission phase/formation signals.
      C. Pen, approach.
      D. After touch down on carrier.
      E. Post flight.

LS: Hierarchy Page

Course, Unit, Lesson: P. 13.5 Title: Hand Signals



#	Topic	Media	Testing
1.	Identify standard pre-start/start hand signals.		M
2.	Identify EA-6B specific hand signals.		M
3.	Describe the rudder throw signals.		
4.	Describe the RAT operation signal.		
5.	Describe the CSD cooling air check signal.		
6.	Describe the fuel transfer check signal.		
7.	Describe troubleshooter signals.		
8.	Describe the 20 degree flap signal.		
9.	Identify Navy standard hand signals.		
EX.	Initiate and respond to start hand signals (completed in 13.1 start trainer).		

The prerequisites to this lesson are:	This lesson is prerequisite to:
P. 13.4	P. 13.1 Start taxi trainer.

P. 11.5
ABORT PROCEDURES

1. State the normal sequence of events during the normal takeoff roll.
   - c. Given takeoff/abort data card properly filled out.
   - s. Cover initial roll, line speed and engine checks, rotation and lift off and abort decision point.

2. Identify abort situations.
   - c. Given a written description of the indicators.
   - s. Correctly identify all situations when aborting is required.

3. State the indicators of a malfunctioning engine.
   - s. Cover gauge readings and line speed indications.

4. State the indicators of an engine fire.
   - s. Cover primary and secondary indications and line speed indications.

5. State the indicators of an adverse cross wind.
   - s. A. Cover directional control inputs and reaction.
   - B. Cover directional limits and indicators.

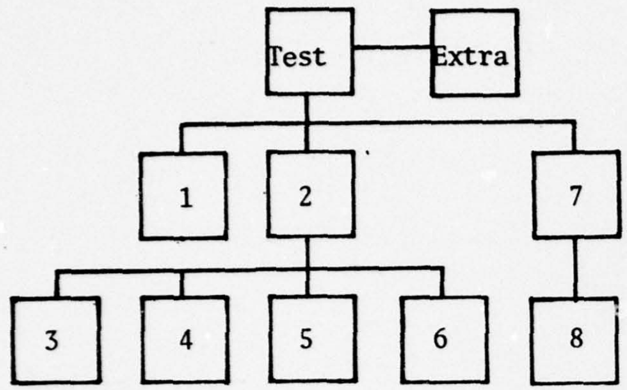
6. State the indications of a blown tire.
   - s. A. Cover directional control inputs and reaction.
   - B. Cover directional limits and indicators.

7. State the abort sequence with an accompanying engine fire.
   - c. Given a cockpit picture or diagram.
   - s. State steps in proper order, identifying which steps may be done simultaneously.

8. State the normal abort sequence.
   - c. Given a cockpit diagram.
   - s. A. State all steps in proper order.
   - B. Identify which steps may be performed simultaneously.

LS: Hierarchy Page

Course, Unit, Lesson: P. 11.5 Title: Abort Procedures



#	Topic	Media	Testing
1.	Normal sequence of events during T.O. roll.	WB	M
2.	Abort situations.	RASW	M
3.	Indications of a malfunction engine.	WB	M
4.	Indications of an engine fire.	WB	None
5.	Indications of an adversers x-wind.	WB	None
6.	Indications of a blown tire.	WB	None
7.	Abort sequence with an engine fire.		M
8.	Normal abort sequence.		M
EX.	Identify and handle abort situation completely in P.11.1		

The prerequisites to this lesson are:

P. 11.6

This lesson is prerequisite to:

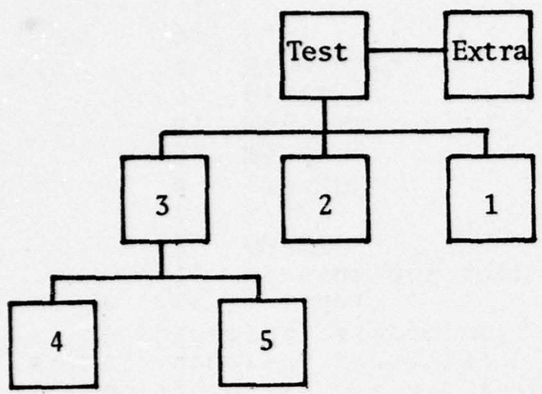
P. 11.1 Launch/departure trainer.

P. 5.6
WAVEOFF AND AFTER TOUCHDOWN PROCEDURE

1. Describe the sequence of events during final approach and landing.
   s. Cover each type of rollout.
2. Locate the controls and state the sequence to perform the after touchdown procedures.
   c. Given a cockpit diagram.
   s. All steps in proper order.
3. Identify a waveoff situation.
   c. Given a written description of the situation.
   s. Identify all waveoff situations.
4. Describe the indicators of no visual contact.
5. Describe the indicators of no ball acquisition.

LS: Hierarchy Page

Course, Unit, Lesson: P. 5.6 Title: Waveoff and After Touchdown



#	Topic	Media	Testing
1.	Describe the sequence of events during final approach and landing.		
2.	Locate the controls and state the sequence of events for the after touchdown procedure.		
3.	Identify a waveoff situation.		
4.	Describe the indicators of no visual contact.		
5.	Describe the indicators of no ball acquisition.		
EX.	a. Perform a directed waveoff. b. Perform a carrier landing. (Completed in P. 5.5)		

The prerequisites to this lesson are:	This lesson is prerequisite to:
P. 10.4	P. 5.5

P. 8
COMPUTER NAVIGATION

1. State the procedures to verify proper data entry.
   - s. A. Cover all steps in proper sequence.
   - B. Cover non-verify readings/ situations.

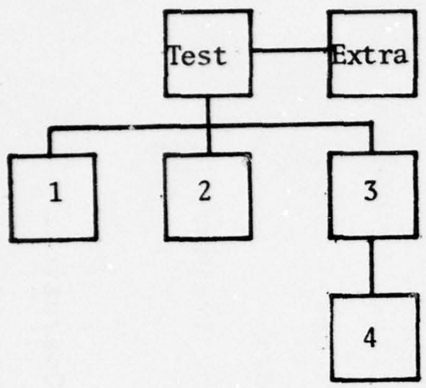
2. State the procedure and locate the controls to enter updated present position data into computer.
   - c. Given cockpit diagram, computer face schematic and PCL.
   - s. A. State steps in proper order.
   - B. Locate all computer controls and indicators.

3. Interpret all CCI readouts.
   - c. Given a description of the computer readouts.
   - s. A. Identify all non-verify/ abnormal readouts.
   - B. Identify all normal readouts to include:
     1. Present position.
     2. GS/GT
     3. R/B/T
     4. TAS/HDG
     5. Wind
     6. MAG VAR
     7. Drift
     8. Site Cur.
     9. P.P.

4. State the procedures and locate the controls to manipulate CCI controls.
   - c. Given a cockpit diagram, computer face schematic and PCL.
   - s. A. State steps in proper order.
   - B. Locate all computer controls and indicators.

LS: Hierarchy Page

Course, Unit, Lesson: P. 8 Title: Computer Navigation



#	Topic	Media	Testing
1.	Procedure to verify data.		M
2.	Procedure to enter updated P.P. into computer.		M
3.	Interpret all CCI readouts.		M
4.	Procedures to manipulate CCI controls.		M
EX.	To be completed in computer navigation trainer.		

The prerequisites to this lesson are:

This lesson is prerequisite to:

EA-6B ECMO COURSE SYLLABUS

Unit 17: Introduction EA-6B Aircraft Systems.

Lesson 10: Introduction to the Engine System.

Lesson 9: Introduction to the Fuel System.

Lesson 8: Introduction to the Electrical System.

Lesson 7: Introduction to the Hydraulic System.

Lesson 6: Introduction to the Environmental System.

Lesson 5: Introduction to the Pneumatic System.

Lesson 4: Introduction to the Aircraft Performance Indicators System.

Lesson 3: Introduction to the Weight-on-wheels System.

Lesson 2: Introduction to the Ejection Seat System.

Lesson 1: Demonstration at NAMTRADET.

Unit 16: Aircraft Initialization.

Lesson 9: Physical Airframe and Cockpit Inspection.

Lesson 8: Flight Gear and Strap-in Procedures.

Lesson 7: Set Up Cockpit Prior to Power.

Lesson 6: Set Up Doppler, ICS, and IFF.

Lesson 5: Hand Signals.

Lesson 4: Prestart and Normal Start Procedure.

Lesson 3: Initialize Pilot Systems.

Lesson 2: Pretaxi/Taxi Procedure.

Lesson 1: Initialization, Start Trainer.

Unit 15: Communications.

Lesson 6: Communication Gear Operation.

Lesson 5: Two Way Voice Communications

Lesson 4: Manage Communication Malfunctions.

Lesson 3: TACAN Navigation.

Lesson 2: TACAN Malfunctions.

Lesson 1: Communications/TACAN Navigation Trainer.

Unit 14: Take-off, Climb-out and Level-off Procedures.

Lesson 7: Pre-take-off Procedure.

Lesson 6: Take-off Engine Checks.

Lesson 5: Abort Procedures.

Lesson 4: Launch, Climb-out, and Level-off Procedures.

Lesson 3: After Launch Procedure.

Lesson 2: Ejection Procedures.

Lesson 1: Take-off, Climb-out and Level-off Trainers.

Unit 13: Normal Penetrations, Approaches, and Landings.

Lesson 6: Approach and Landing Parameters.

Lesson 5: ADF and TACAN Penetrations.

Lesson 4: Approach and Landing Procedures.

Lesson 3: Missed Approaches.

Lesson 2: Post-flight Procedures.

Lesson 1: Penetration, Approach and Landing Trainer.

Unit 12: Aircraft Malfunction.

Lesson 18: Engine Malfunctions.

Lesson 17: Airconditioning and Environmental System Malfunctions.

Lesson 16: Engine and Environmental Malfunctions Trainer.

Lesson 15: Electrical Malfunctions.

Lesson 14: Identify Hydraulic Malfunctions.

Lesson 13: Identify Hydraulic Operated Component Malfunctions.

Lesson 12: Respond to Hydraulic Malfunctions.

Lesson 11: Starting Malfunctions.

Lesson 10: Electrical, Hydraulic, and Starting Malfunctions Trainer.

Lesson 9: Fuel Malfunctions.

Lesson 8: After-lift-off Malfunctions.

Lesson 7: TJS Malfunctions.

Lesson 6: Fuel and Performance Indicators and TJS Malfunctions Trainer.

Lesson 5: After-lift-off Malfunctions.

Lesson 4: Excessive Angle-of-attack Emergencies.

Lesson 3: Manage Spins and Damaged Aircraft.

Lesson 2: Emergency Situations - Priorities.

Lesson 1: Malfunctions Trainer.

Unit 11: Navigation and Flight Planning.

Lesson 12: Dead Reckoning Navigation.

Lesson 11: Navigation Computer Operation.

Lesson 10: Insert NAV data.

Lesson 9: Response to Invalid CCI Readouts.

Lesson 8: Manage NAV Computer Malfunctions.

Lesson 7: Navigation Flight (using computer).

Lesson 6: Radar Operation.

Lesson 5: Interpret the Radar.

Lesson 4: Radar Navigation Trainer.

Lesson 3: Radar Turnpoint Predictions.

Lesson 2: Radar Malfunctions.

Lesson 1: Radar Navigation Trainer and Flight.

Unit 10: Brief and Debrief.

Lesson 5: General Crew Briefing Responsibilities.

Lesson 4: Briefing Items.

Lesson 3: Review of VIDS Cards.

Lesson 2: Debriefing Items.

Lesson 1: Brief and Debrief Exercise.

Unit 9: TJS/OBS Introduction.

Lesson 4: General Operation of TJS.

Lesson 3: Contents of DDI Displays.

Lesson 2: Available Modes and Modes of TJS.

Lesson 1: Trainer - TJS/OBS Demonstration.

Unit 8: ECM Targets.

Lesson 9: Chart Construction (review).

Lesson 8: Radars of Interest.

Lesson 7: Naval and Air Orders of Battle.

Lesson 6: Detection Ranges.

Lesson 5: Weapons Envelope.

Lesson 4: Victim Radars' Susceptibility to DECM.

Lesson 3: Flight Altitude Profile.

Lesson 2: Burn Through Range.

Lesson 1: Assets and Support Availability.

Unit 7: TJS Cockpit Set-up.

Lesson 7: ECMO-2/3 Cockpit Set-up.

Lesson 6: Trainer - ECMO-2/3 Cockpit Set-up.

Lesson 5: Receiver Monitor Panel Operability Test.

Lesson 4: Init: DTR, BDHI, Bd 7 Atten., Bd 8/9 Sens.

Lesson 3: DDI Displays.

Lesson 2: DDI Set-up and Operability Test.

Lesson 1: Trainer - DDI Tableaus, DDG Operation Test, RCVR MON PAN, DTR, BDHI, PW Strip, BDS 7 and 8/9.

Unit 6: TJS - DDG Data Entry.

Lesson 5: Data Entry and Initial Tableau.

Lesson 4: Data Entry in List Tableau.

Lesson 3: FREQ-AZ Display.

Lesson 2: DDG Malfunctions.

Lesson 1: DDG, Data Entry, Malfunctions.

Unit 5: TJS Operation.

Lesson 9: Videoscope Interpretation.

Lesson 8: Videoscope Operations and Malfunctions.

Lesson 7: Manually Turning the OBS.

Lesson 6: Training - Interpreting and Operating Videoscope, Manual Turning of OBS.

Lesson 5: Pod Procedures and Malfunctions.

Lesson 4: Manual Pod Set-ons.

Lesson 3: Blind Pot Set-ons.

Lesson 2: BIT.

Lesson 1: Trainer - Pods, Blind and Manual Set-ons, BIT.

Unit 4: Pre-emptive Jx Plan.

Lesson 10: Pre-emptive and Display Assigns.

Lesson 9: Interpreting the Jammer Status Panel.

Lesson 8: Trainer - Pre-emptive and Display Assigns.

Lesson 7: Alarm Assignment.

Lesson 6: FREQ AZ Manipulation.

Lesson 5: Trainer -Alarm Assigns and FREQ AZ Manipulation

Lesson 4: Verifying Pod Parameters.

Lesson 3: Trainer -Verify Pod Parameters.

Lesson 2: Spot Monitor Operation, Utilization, and Modulation Optimalization.

Lesson 1: Trainer - Spot Monitor Operation and Modulation Optimalization.

Unit 3: TJS Tactics.

Lesson 8: Target Priorities.

Lesson 7: Tactics Against EQ/ACQ/GCI Radars.

Lesson 6: Tactics Against Missile Threats - Associated Radars.

Lesson 5: Tactics Against AAA/FC Radars.

Lesson 4: Tactics Against AI Radars.

Lesson 3: Tactics Against GCI Communications.

Lesson 2: Jx Management - Standoff and Escort.

Lesson 1: Jx Management - ASMD.

Unit 2: Lists and List Usage.

Lesson 4: List Numbers, FREQ's PRF, and Pre-tolerance.

Lesson 3: Determining Modulations.

Lesson 2: List Usage - List Type, WCS Numbers, Symbol Numbers.

Lesson 1: List Usage - PW Stripping, Alarm Zones, et. al.

E. 8.7

NAVAL AND AIR ENEMY ORDERS OF BATTLE

1. Plot enemy fighter threats and AI radar types.
   - c. Given updated chart and fighter threat and AI radar locations.
   - s. Plot all threats to within ± 5 miles of their parent airfields.
2. Determine non-radar threat emissions associated with aircraft types.
   - c. Given message traffic, DIA fact book, EA-6B TACAID and aircraft type.
   - s. Determine all air associated non-radar threat emissions.
3. Determine presence of AI radar types.
   - c. Given message traffic, DIA fact book, EA-6B TACAID and aircraft type.
   - s. Determine presence of all AI radar types.
4. Determine enemy fighter presence.
   - c. Given message traffic and DIA fact book,
   - s. Determine all fighter presence.
5. Plot locations of enemy naval threat radars.
   - c. Given updated chart and naval threat locations.
   - s. Plot all threats to within ± 1 mile.
6. Determine enemy naval presence.
   - c. Given message traffic and DIA fact book
   - s. To within the accuracy of available information on naval presence and ship movements.

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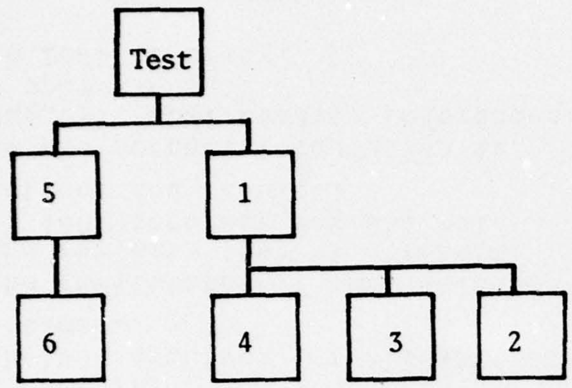
Course, Unit, Lesson: E. 8.7 Title: Naval and Air Orders of Battle



#	Topic	Media	Testing
1.	Plotting of enemy fighter threats and AI radar types.		M
2.	Determination of threat emissions associated with aircraft types.		M
3.	Determination of AI radar types.		M
4.	Determination of enemy fighter presence.		M
5.	Plotting of enemy naval threat radar locations.		M
6.	Determination of enemy naval presence.		M

The prerequisites to this lesson are:

This lesson is prerequisite to:

E. 7.4

DTR, BDHI, PW STRIPPING, ATTENUATION, AND SENSITIVITY

1. State the procedures and locate the controls to select desired Band 7 attenuation and Band 8/9 sensitivity.
   c. Given a detailed drawing of the aft cockpit.
   s. With 100% accuracy for all steps and controls.

2. State the procedures and locate the controls to select desired pulsewidth stripping.
   c. Given a detailed drawing of the aft cockpit.
   s. With 100% accuracy for all steps and controls.

3. State the procedure and locate the controls to respond to BDHI malfunctions.
   c. Given a detailed drawing of the aft cockpit.
   s. With 100% accuracy for all malfunctions.

4. State the indications of BDHI malfunctions and the data lost as a result.
   c. With 100% accuracy for all malfunctions and results.

5. Describe the potential confusion in using magnetic BDHI heading references for TJS operation.
   s. With 100% accuracy.

6. State the procedure and locate the controls to select desired BDHI heading reference.
   c. Given a detailed drawing of the aft cockpit.
   s. With 100% accuracy.

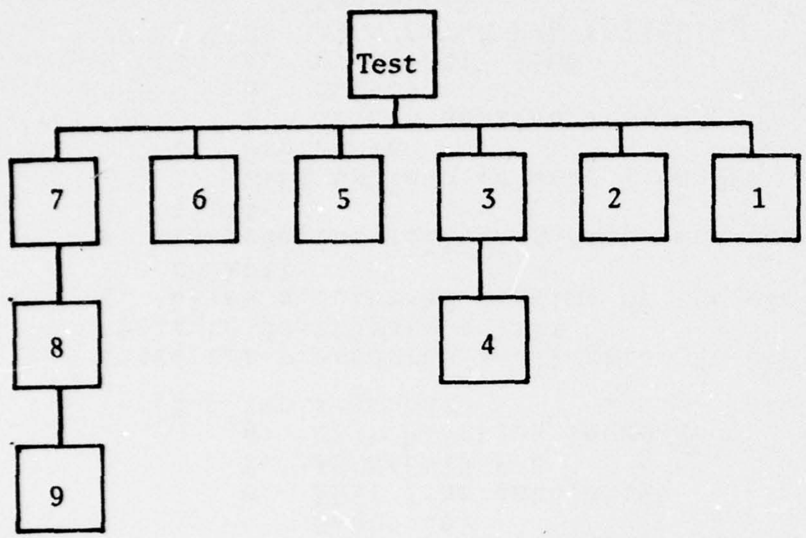
7. State the procedures and locate the controls to respond to DTR malfunctions.
   c. Given a detailed drawing of the aft cockpit.
   s. With 100% accuracy for all malfunctions.

8. Indications of DTR malfunctions.
   s. With 100% accuracy for all malfunctions.

9. State the procedure and locate the controls to turn on the DTR.
   c. Given a detailed diagram of the aft cockpit.
   s. With 100% accuracy for all steps and control.

LS: Hierarchy Page

Course, Unit, Lesson: E. 7.4   Title: DTR, BDHI, PW Stripping, Attenuation & Sensitivity



#	Topic	Media	Testing
1.	Procedure and controls to select desired band 7 attenuation and band 8/9 sensitivity.		M
2.	Procedures and controls to select desired pulsewidth stripping.		M
3.	Procedures and controls to respond to BDHI malfunctions.		M
4.	Indications of BDHI malfunctions.		M
5.	Problem associated with using magnetic BDHI HDG reference for TJS operation.		M
6.	Procedure and controls to select desired BDHI heading reference.		M
7.	Responses to DTR malfunctions.		M
8.	Indications of DTR malfunctions.		M
9.	Procedures and controls to turn on DTR.		M

The prerequisites to this lesson are:

This lesson is prerequisite to:

E. 6.4
DATA ENTRY IN LIST TABLEAU

1. State the procedure and locate the controls to activate a list.
   - c. Given a detailed drawing of the aft cockpit.
   - s. Include the following steps and controls and state the implications of this method of list activation:
     1. LIST tableau in Zone V on DDI
     2. Procedure
        - a. Select desired list
        - b. Cursor
        - c. Clear EDIT line
        - d. ASGN/ENTR P/B (Blinking Sequence)
        - e. EDIT line data entry
        - f. ASGN/ENTR P/B
        - g. Exit blinking sequence
     3. Implications

2. State the procedures and locate the controls to deactivate a list
   - c. Given a detailed drawing of the aft cockpit
   - s. Include the following steps and controls
     1. LIST tableau in Zone V on DDI
     2. Procedure
        - a. Select desired list
        - b. Cursor
        - c. Clear EDIT line
        - d. ASGN/ENTER P/B (Blinking Sequence)
        - e. LIST number on EDIT line
        - f. CLR P/B
        - g. Exit blinking sequence

3. State procedure and locate controls to change data in LIST tableau.
   - c. Given detailed drawing of aft cockpit.
   - s. Include the following steps and controls
     1. Call up LIST tableau in Zone V on DDI
     2. Cycle through lists until desired list is displayed.
     3. Select desired list and enter it.
     4. Cycle through list until parameter to be changed is blinking.
     5. EDIT line data entry/ASGN/ENTR P/B
     6. EXIT blink sequence

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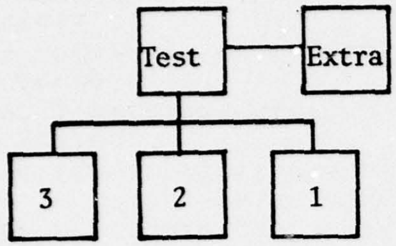
Course, Unit, Lesson: E. 6.4   Title: Data Entry in LIST Tableau



#	Topic	Media	Testing
1.	Procedures and controls to activate individual lists.		M
2.	Procedures and controls to deactivate individual lists.		M
3.	Procedures and controls to change data in LIST tableau.		M
EX.	Data entry procedures completed in Trainer E. 6.1.		

The prerequisites to this lesson are:

This lesson is prerequisite to:

E. 5.8
VIDEOSCOPE OPERATION

1. Describe the effects of videoscope malfunctions on TJS effectiveness.
   - s. 100% accuracy
     - a. Computer Normal Operations
     - b. Degraded Systems Operations

2. State the procedure and locate the controls to respond to videoscope malfunctions.
   - c. Given a detailed drawing of the aft cockpit.
   - s. 100% accuracy for the following steps and controls for the malfunction indicated.
     - a. (See E.5.8.3)

3. State the indicators of a videoscope malfunction.
   - s. 100% accuracy for the following malfunctions and indicators.
     - a. No information displayed on either videoscope.
     - b. No information displayed on one videoscope.

4. State the procedure and locate the controls to adjust pulse width scales and state the implications of using various scales.
   - c. Given a detailed drawing of the aft cockpit,
   - s. 100% accuracy for the following controls.
     - a. MSEC/CM Switch

5. State the procedure and locate the controls to adjust audio.
   - c. Given a detailed drawing of the aft cockpit.
   - s. 100% accuracy for the following steps and controls.
     - a. Band Activity Panel
     - b. VID BND SEL switch
     - c. Audio knob
     - d. Radio Mixer Panel

6. State the procedure and locate the controls to call up TJS band using video band select.
   - c. Given a detailed drawing of the aft cockpit,
   - s. 100% accuracy for the following steps and controls.
     - a. Band Activity Panel
     - b. VID BND SEL switch

7. State the procedure and locate the controls to adjust intensity, scale illumination, PRF multiplier, and synchronization level.
   - c. Given a detailed drawing of the aft cockpit,
   - d. 100% accuracy for steps and controls for the adjustment indicated:
     - a. Intensity
     - b. Scale illumination
     - c. PRF multiplier
     - d. Sync level

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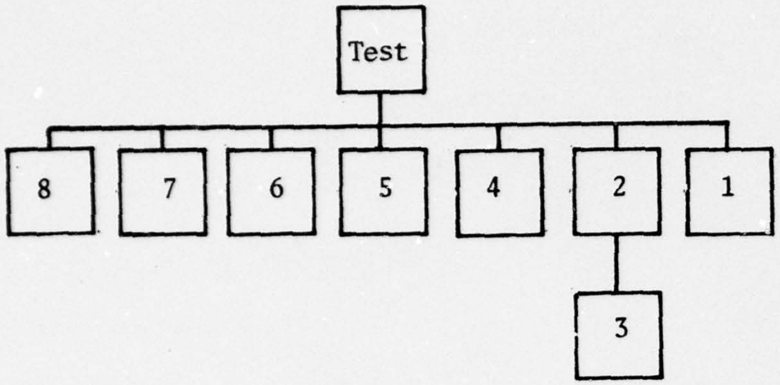
Course, Unit, Lesson: E. 5.8 Title: Videoscope Operation and Malfunctions



#	Topic	Media	Testing
1.	Effects of videoscope malfunctions on TJS effectiveness.		M
2.	Procedure and controls to respond to videoscope malfunctions.		M
3.	Indicators of videoscope malfunctions.		M
4.	Procedure and controls to adjust pulse width scales.		M
5.	Procedure and controls to adjust audio.		M
6.	Procedure and controls to call up TJS band.		M
7.	Procedure and controls to adjust intensity, scale illumination, PRF multiplier, and sync level.		M
8.	Procedure and controls to conduct a videoscope operability test.		M
EX.	Procedure and controls to conduct a videoscope operability test		

The prerequisites to this lesson are:

This lesson is prerequisite to:

Appendix F

Extract from the Training Support Requirements Document

The purpose of the Training Support Requirements Document is to present four alternative approaches to instructional media and equipment for EA-6B (ICAP) training and to outline the rationale and implications of each. These alternatives are for consideration by the Navy in planning requirements for the Phase II and beyond. In order to accomplish this purpose several key items will be presented in this document. First, a listing of the medium selected for each lesson will be presented for each of the four media plans. Second, the rationale underlying each media plan will be outlined, and finally, the relative costs of implementing each media plan will be discussed.

Prior to media selection, an ISD procedure had been carried out. It included Job Analysis, Selection of Tasks for Training, development of Objectives Hierarchies, and organization and sequencing of objectives. Once the objectives were sequenced, media selection was begun. First level (preliminary) media decisions were made by using a computer program to select optimal and acceptable (but not optimal) media alternatives for each objective. This selection was made based on the type of content, the type of behavior, the sensory display requirements, and memory load indicated for each objective. The specific selection model used in the computer program is presented in Appendix A. Briefly, the procedure was to ask the same five questions about each objective. The questions are shown in Figure F-1. Their intent was to determine the critical features of the objective which determine the specific medium or media that would teach the objective in a facilitative manner. Question 1 gets at the kind of behavior that the objective requires the learner to

QUESTION 1:

What is the level of behavior expected of the student in this segment?

1 = familiarization
2 = discriminated recall
3 = rule-using

QUESTION 2:

What level of content is being taught in this segment?

1 = familiarization
2 = paired associate
3 = concept
4 = rule

QUESTION 3:

Is the minimum critical set of instances the student needs to see small or large?

1 = small
2 = large

QUESTION 4:

What is the minimum display requirement?

1 = verbal and/or symbolic and/or static simple pictorial
2 = verbal and/or symbolic and/or static complex pictorial
3 = dynamic pictorial
4 = interactive

QUESTION 5:

Is the memorization component of this objective large or small?

1 = small
2 = large

Figure F-1. Questions and Coded Responses Used as Input to First Level Media Selection for Individual Objectives

display. Question 2 determines the type of content inherent in the objective. The content level is significant because paired associate content does not require a medium which can present a large set of examples and practice items, whereas concept and rule content does. Since the size of this set of instances may be large or small, the medium selected must be able to present them economically and conveniently. Question 3 establishes the degree of variability in the illustrative examples and practice items that would be required to teach the objective thoroughly. Question 4 deals with content again, but this time focuses on the kind of display the learner must see in order to fully understand the material (e.g., it is difficult to understand complicated machinery from a verbal display only). Question 5 determines the degree of memory load demanded in learning the objective. These five variables are the essential determiners of suitable instructional media. The way in which responses to these questions was processed through the model to arrive at a media selection is described in the appendix.

These first level media selections were essentially unconstrained. That is, they were based on optimum learning considerations only. In order to work these selections into a feasible teaching sequence, second level media decisions were made. During this process the media selected for each objective within a lesson were examined, and the number of different media used for the lesson was narrowed to one. The one medium chosen was the best suited for <u>all</u> lesson objectives. The result of this procedure was that many segments were recommended

for presentation in an acceptable, but non-optimal medium. The reason for doing this is that the student has much less trouble completing a lesson presented in a single medium than completing a lesson presented in three or four different media. This also reduces the training administration and scheduling load. During this consolidation process, second and third alternative media choices were also made. That is, while the best medium for each lesson was chosen, acceptable alternative media were also recorded.

At this point in the process, media had been selected on the basis of learning efficiency and administrative ease. The question still remained as to the availability of the types and numbers of equipments and devices for further development and actual implementation in Phase II of the EA-6B (ICAP) ISD project. Other than what equipment was on hand and scheduled for delivery, no information was available on this question.

Discussions were held with NAVTRAEQUIPCEN and VAQ-129 representatives. These resulted in four different assumptions about media availability. Each assumption represented a different set of potential restrictions. Taken together, the four assumptions represented possibilities ranging from almost unrestricted to severely restricted

Second level media decisions for each lesson were then compared to the four sets of restrictions, and the best media for each lesson was selected within the assumed media constraints. This procedure resulted in four alternate media plans for the pilot and ECMO courses. The relative advantages of each of these plans was then analyzed, and a set of recommendations was developed. The results of this entire media selection procedure have been summarized

in this document.

The Four Media Plans

The four assumed sets of media restrictions are described below. It should be pointed out that there are an infinite number of assumptions that could be made. The selection of these four was based on discussions with NAVTRAEQUIPCEN and VAQ-129 personnel, and was thought at the time to provide a sufficiently wide range of practical options. A full definition of each of the media terms appears in Appendix B.

Media Plan #1:

The first media plan assumed that all of the media listed in Appendix B are available for use in any proportions needed.

Specifically, these media are:

1. Workbook (WB)
2. Slide-tape presentation (ST)
3. Video-tape presentation (VT)
4. Computer-assisted instruction (CAI)
5. Random access slide presentation (RAS)
6. Aircraft flight (AC)
7. Mediated interactive lecture (MIL)
8. Forward cockpit procedures trainer exercise (CPT)
9. Part task trainer exercise (PTT)
10. Weapons system trainer exercise (WST)

This plan allows the optimum media identified in the level two media selections to be used in every case.

Media Plan #2:

The second media plan also presupposes that all ten media listed above are available for use in any proportion. However, in addition, this plan specifies that CAI will be used as the presentation media wherever it is an acceptable choice (i.e., first, second, or third choice). The reason that this plan was selected for consideration is that CAI is traditionally viewed as an acceptable but expensive medium, especially for lower level instruction (where the system essentially becomes a "page turner"). However, if CAI is justified on the basis of its need for higher (i.e., concept and rule) level instruction, then the system can be used for lower level instruction with little or no added hardware and software cost. Then the issue becomes the relative development costs of this approach compared to other media plans.

Media Plan #3:

The third media plan makes the assumption that CAI is not available but that all other media are available and can be used in any proportion.

Media Plan #4:

The last media plan selected for consideration assumes that CAI, RAS presentations, and WST exercises are not available. It also assumes that VT presentations are limited to "home movie" quality productions which can be used in a classroom setting only. The other media are available for use in the necessary proportions. This media plan was chosen for consideration because it most closely represents the type of course VAQ-129 could conduct with presently

available or scheduled squadron resources. The only unscheduled resource this plan requires is a forward CPT. This was included because after careful analysis it was determined that it would be impossible to meet all course objectives without at least a forward CPT. A functional specification for a CPT appears in Appendix E.

Resources and Costs for Each Plan

Appendix C presents for each lesson a listing of the second level media decisions (best and alternate media for a whole lesson), and the final media choices under the assumptions outlined in each of the four media plans (best media for each lesson within the media availability restrictions). Table A-2 presents in summary form the number of segments in each media for each media plan.

Table A-1 presents the costing data that was used to determine the relative development costs of each media plan. The entries in the table show the relative costs and time requirements for preparing materials in each medium. For example, it requires one and one-third times as much instructional developer time to prepare a slide tape script as it does to prepare a concept level workbook.

There are two assumptions underlying these relative costing figures which must be made clear. The first assumption is that the developers are given a complete, well written lesson specification to work from. It has been found that the cost up to and including the development of lesson specifications is relatively independent of the presentation media selected. The second assumption is that only one hard copy of each finished product is

produced. This means that the cost of reproducing additional copies or sets of lesson materials is not included.

To determine the relative time and cost requirements for each of the media plans, the percentage of segments in each media of a media plan can be multiplied by the corresponding relative production costs outlined in Table A-1. The results of this procedure for the four media plans are presented in Appendix D. A summary of the totals in each category for each media plan is presented in Table A-3.

It should be stressed that the figures in Table A-3 are both relative (not absolute) and approximate. They are relative in that it can not be said that total authoring time in Media Plan #2 is 914 hours (or days or years). It can be said that total authoring time in Plan 2 is 1.11 times as much as total authoring time in Plan 4. As pointed out above, these totals are also approximate since they are based on only a small number of actual, relevant experiences. As further experience is gained, these figures should become more precise.

Media Plan Comparisons

A comparison of alternative media plans is an extremely complicated procedure because of the many interdependent factors involved. Some of these factors (such as development costs) can be quantified but many of them cannot. In order that this comparison has some logical order, the discussion has been divided into three sections. The first section presents a comparison of the instructional materials development costs. The second section compares the hardware purchase costs, and the third section outlines the implementation requirements

and problems related to the alternative media plans.

Instructional Materials Development Cost Comparisons

Table A-3 presents a concise summary of the relative courseware development costs for each media plan. While in some cases the relative differences between time categories are significant, most comparisons show less than a 10% to 15% difference in the time requirements. For example, the relative SME time required shows only a 14% difference between the highest cost (Plan 3) and the lowest cost (Plan 4) media plans. This means that the initial courseware development effort would require 14% more SME resources for Plan 3 than for Plan 4. It is interesting to note that the two CAI plans are relatively less costly than their non-CAI counterparts. This is due primarily to the lower requirements in CAI for the technical and support personnel involved in producing hard copy instruction (e.g., text, pictures, audio, etc.).

Required Hardware and Facility Procurement

Since there are some media or devices which are either already programmed or common to all plans, they will not be included with each plan separately. These are:

1. A tactics trainer for the rear cockpit (15E22A).
2. A weapons system trainer (2F119). (This device is projected to be ready for training in January 1978.)
3. Actual EA-6B ICAP aircraft.
4. A cockpit procedures trainer for the forward cockpit. This device has not been ordered, but is an

interim requirement for the WST.

5. 15E34 Replacement Trainer. The present 15E34 Trainer is not adequate to fully stimulate the tactical jamming system of the EA-6B ICAP aircraft. Requirements for the trainer are outlined in more detail in Appendix F.

In addition to these devices, the requirements for each media plan are outlined below.

Media Plan 1: The major additional hardware requirement for this plan is a CAI system. While this plan also has a VT viewing requirement, the particular CAI system being considered has this capability built into it. This media mix requires a small number of slide projectors, tape recorders and synchronizers to be used for the ST presentations. In addition, it requires a small student learning center facility as an add-on to a CAI terminal room.

Media Plan 2: As with Plan 1, this plan requires a CAI system. However, this plan does not require slide projectors, audio recorders or synchronizers, or student learning center.

Media Plan 3: This media plan requires the use of six to ten random access slide projectors. In addition, there is the requirement for a small number of slide projectors, audio recorders, and synchronizers. This plan would require two color TV monitors and VT playback units. It also requires a substantial student learning center facility.

Media Plan 4: In accord with its original purpose, this plan

requires very few hardware purchases. VT viewing can be handled by the TV monitors already available in VAQ-129. This plan, however, will require the acquisition of a small number of slide projectors, audio recorders, and synchronizers, and the establishment of a student learning center facility.

Implementation Comparisons

While the costs and time involved in the initial course development are important considerations in selecting a media plan, a far more lasting consideration are the implementation and revision requirements incurred as a result of adopting each plan.

The first implementation factor to consider is the number of instructors required by each plan. Since, in all plans, the use of MILs has been avoided to allow for individualization of instruction, there is no requirement for stand-up lectures. However, in all plans there is still the need for instructor-proctors to supplement existing hard-copy materials (e.g., field questions, provide direction). This requirement is larger for the non-CAI plans, because non-CAI media can not provide as wide a range of instructional components as can a CAI system. Consider the logistics of providing a large set of examples and practice items with accompanying helps using a WB format. There is also a greater instructor requirement for non-CAI plans since the instructor must be an "advisor". The CAI system has a built-in "advisor" which gives the student directions about what he should do when he is in trouble.

Another implementation factor to be considered is testing, which is tied to instructor requirements. Any media plan must

provide for the evaluation of students using criterion-based tests. This capability is provided for in Plan 1 and 2 through the CAI system. For non-CAI plans it is expected that this requirement will be met through the use of paper and pencil, instructor monitored and scored tests. Thus, non-CAI media plans will have a larger instructor requirement in this area.

Closely related to the implementation factor of testing are the areas of record keeping and scheduling. VAQ-129 presently has three officers assigned to perform these duties. It is expected that this requirement will be the same if media Plan 3 or 4 is implemented. The CAI system has a built-in capability for these two functions, and would partially negate the need for these personnel.

Another factor of importance when considering alternative media plans is hardware maintenance. The maintenance requirements of the CPT, PTT, WST, and AC will be the same for all media plans. There is a relatively low maintenance requirement for VT players, audio recorders, slide projectors, and synchronizers. The only major hardware item of interest is a CAI system. A CAI system has a significant staffing requirement for operators and maintenance personnel.

Another factor which must be considered in media plan selection is the requirement for instructional material to be produced in a back-up media. If a slide projector or audio recorder breaks during a presentation, it is possible to get a back-up device with relatively little delay. Therefore, in non-CAI media plans there is a very little need for instruction to be produced in a back-up

medium. However, when CAI is employed, the need for back-up presentations becomes greater. There are several alternative paths which can be taken to solve this problem. It is possible to develop MILs at a low cost as an alternative. It is also possible to use the CAI system to print out selected instructional components in WB format for lesson materials. Whatever solution is selected, it is critical that this factor be considered when choosing a media plan.

In the Job Analysis Document it was indicated that approximately 20% of the EA-6B curriculum changes each time a new class begins. Therefore, another factor for consideration in selecting a media plan is the ability to quickly and efficiently revise lesson material to keep it current with the job requirements. One of the columns in Table A-1 gives comparative estimates of the turnaround time for revision of instructional materials in each media. Based on these estimates, Media Plan 2 would provide for the fastest update capability. This plan would be followed in order by Plans 1, 4, and 3.

The reason for the shorter turnaround time for revision of CAI instructional materials is two-fold. First, CAI has modular instructional components. This means that one component can be changed without a requirement to reproduce the entire lesson. If changes are made in an instructional component of another medium, such as the generality (see Appendix B) of a WB, or the audio of a ST presentation, the entire lesson must be submitted for one or more phases of production again. The second reason for faster revision of CAI materials is that all of it can be

done without interface with outside production agencies. When it becomes necessary to interact with outside agencies, delays can easily occur due to their schedules and operating characteristics.

To summarize, the following factors related to course implementation must be considered when selecting a media plan:

1. Instructor-proctor requirements
2. Testing requirements
3. Record keeping and scheduling requirements
4. Hardware maintenance requirements
5. Back-up instructional media requirements
6. Efficient revision and update requirements

Based on the factors listed above, and on present VAQ-129 staffing levels, a tentative set of staffing requirements has been developed for each media plan. A summary of this data is shown in Table A-4. The responsibilities of the individuals listed within each category in this table may change slightly for each media plan. However, their job duties are still within the category listed. For example, the secretarial support for the ISD team will mostly type WBs and worksheets if Media Plan 3 or 4 is selected, but they will be required to do CAI data entry if Media Plan 1 or 2 is adopted. In either case, their responsibilities still fall within the job category of a secretary.

Media Plan Recommendations

There are so many factors that must be considered and weighed in the selection of a media plan, that the final recommendation must be viewed in part as subjective. If different weights were given to these factors, it is possible that a different plan would

be recommended. However, if it is assumed that the factors of highest importance are course quality, instructor load, and course revisability, then the recommendations below follow logically from the data which has been presented.

It is recommended that Media Plan 2 be adopted. This plan was selected instead of Plan 1 because Plan 1 has the disadvantages of a CAI system (e.g., high hardware cost, added computer maintenance personnel cost, requirement for back-up media) with less of a potential benefit from its advantages (e.g., instructors are still required for non-CAI materials). Plan 2 was selected over Plan 3 or 4 because the advantages of using a CAI system (e.g., personnel savings, ease of revision) outweigh the initial added hardware purchase costs.

If Media Plan 2 is adopted it is recommended that a set of back-up instructional materials be prepared for each lesson using the CAI system to print selected instructional components in WB format.

If, for budgetary or other reasons, it is impossible to implement Media Plan 2, then it is recommended that Media Plan 3 be adopted. However, if budgetary constraints exclude Plan 3, then Plan 4 is recommended. If Plan 4 is adopted it is recommended that consideration be given to using RAS presentations and professional level VTs in those cases where the instructional benefits do outweigh the high preparation costs. These decisions must be made on a case by case basis.

Finally, if Media Plan 4 is selected, it is recommended that the staffing requirements be studied carefully. If this plan is

not properly staffed, it is very probable that the revision of the instructional materials will be unmanageable, and that the benefits of ISD will be subsequently lost after the program has been in effect for only a short time.

Appendix A

LEVEL ONE MEDIA DECISION MODEL

As previously described, level one media decisions were made through the use of a computer program. The input to this program for each objective were the answers to five media selection questions. Based on these inputs the computer sorted each objective into one of 44 categories. The specific sort algorithm used is shown in Figure A-1. The meaning of each of the decision points (Q1-Q5) is outlined in Figure A-2, and the meaning of the terminal boxes or categories (M1-M44) in the model is listed in Figure A-3.

An example showing how the model functions may help to clarify its utility. One of the Pilot course objectives is:

Identify an engine failure.
Conditions: Given a written description of abnormal cockpit indications.
Standard: Correctly diagnose what the actual malfunctioning system is.

The answers to the five media decisions are:

Q1 = 3 = This objective requires rule-using behavior.

Q2 = 3 = This objective deals with concept level content.

Q3 = 2 = The minimum critical subset of instances is large.

Q4 = 1 = The minimum display requirement is verbal and/or symbolic.

Q5 = 2 = The memorization component of this objective is large.

This input is next entered into the sorting algorithm at the black triangle. Figure A-4 highlights the path that is taken based on the answers to Q1-Q5. The terminal media category selected for this objective is M34. By referring to Figure A-3, it is found the media choices are:

First choice: CAI

Second Choice: RAS

Third Choice: WB

Fourth Choice: MIL

A note has also been included for this media category to ensure that the large memorization component in the objective is handled properly in a separate segment.

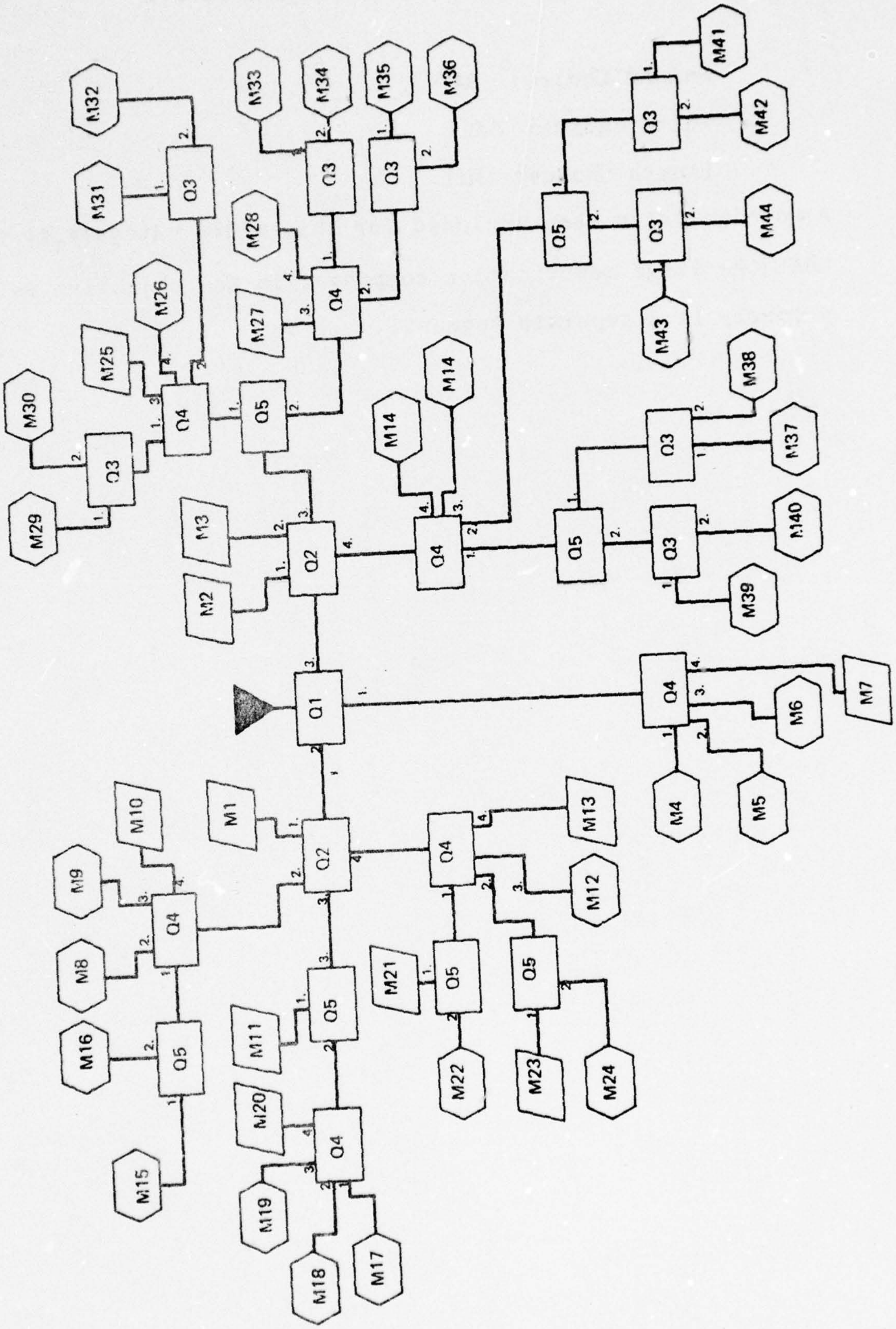


Figure A-1. Media Selection Model

Q1 is the number of the choice which best answers this question for a given objective:

What is the level of behavior expected of the student in this segment?
1 = familiarization
2 = discriminated recall
3 = rule using

Q2 is the number of the choice which best answers this question for a given objective:

What level of content is being taught in this segment?
1 = familiarization
2 = paired associate
3 = concept
4 = rule

Q3 is the number of the choice which best answers this question for a given objective:

Is the minimum critical set of instances the student needs to see small or large?
1 = small
2 = large

Q4 is the number of the choice which best answers this question for a given objective:

What is the minimum display requirement?
1 = verbal and/or symbolic and/or static simple pictorial
2 = verbal and/or symbolic and/or static complex pictorial
3 = dynamic pictorial
4 = interactive

Q5 is the number of the choice which best answers this question for a given objective:

If the memorization component of this objective large or small?
1 = small
2 = large

Figure A-2. Key to Meaning of Q1 - Q5 Used in Media Selection Model

Media #1

Familiarization level content should not be taught at a recall level.

Media #2

Familiarization level content should not be taught at a rule-using level.

Media #3

Paired associate level content should not be taught at a rule-using level.

Media #4

First Choice: Workbook
Second Choice: Mediated interactive lecture

Media #5

First Choice: Mediated interactive lecture
Second Choice: Slide-tape presentation

Media #6

First Choice: Videotape
Warning: It may not be worth the expense.

Media #7

It is probably a waste of time and resources to teach this objective at a familiarization level.

Media #8

First Choice: Slide tape
Second Choice: Mediated interactive lecture

Media #9

First Choice: Videotape
Second Choice: Mediated interactive lecture

Media #10

Why is an interactive presentation needed to teach discriminated recall level behavior?

Figure A-3. The Meaning of Each of the 44 Terminal Categories in the Media Selection Model

Media #11

You may want to combine this objective with the classification level objective dealing with this content.
First Choice: Workbook
Second Choice: Mediated interactive lecture

Media #12

First Choice: Videotape
Second Choice: Mediated interactive lecture

Media #13

Why do you need an interactive simulation to teach a discriminated recall level behavior?

Media #14

First Choice: A simulator or the actual equipment and a worksheet.
Second Choice: CAI simulation

Media #15

First Choice: Workbook
Second Choice: Slide tape
Third Choice: Mediated interactive lecture

Media #16

First Choice: CAI (memory)
Second Choice: Workbook
Third Choice: Slide tape

Media #17

First Choice: CAI (memory)
Second Choice: Workbook
Third Choice: Slide tape

Media #18

First Choice: CAI (memory)
Second Choice: Slide tape
Third Choice: Workbook

Media #19

First Choice: Videotape
Second Choice: Mediated interactive lecture

Figure A-3. (continued)

<u>Media #20</u>

Why do you need an interactive presentation to teach a discriminated recall level behavior?

<u>Media #21</u>

You may want to combine this objective with the workbook portion of the rule-using level objective dealing with the content.

First Choice: Workbook
Second Choice: Mediated interactive lecture

<u>Media #22</u>

First Choice: CAI (memory)
Second Choice: Workbook
Third Choice: Slide tape

<u>Media #23</u>

You may want to combine this with the workbook portion of the rule-using level objective dealing with this content.

First Choice: Slide tape
Second Choice: Workbook

<u>Media #24</u>

First Choice: Videotape
Second Choice: Mediated interactive lecture

<u>Media #25</u>

First Choice: Videotape
Second Choice: Mediated interactive lecture (with VT).

<u>Media #26</u>

First Choice: Simulator
Second Choice: CAI simulation
Third Choice: Videotape

<u>Media #27</u>

First Choice: Videotape
Second Choice: Mediated interactive lecture (with VT).
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Figure A-3. (continued)

Media #28

First Choice: Simulator
Second Choice: CAI Simulation
Third Choice: Videotape

Media #29

First Choice: Workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Random access slide-workbook

Media #30

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Workbook
Fourth Choice: Mediated interactive lecture

Media #31

First Choice: Random access slide-workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook

Media #32

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook

Media #33

First Choice: Workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Random access slide-workbook
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Media #34

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Workbook
Fourth Choice: Mediated interactive lecture
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Figure A-3. (continued)

Media #35

First Choice: Random access slide-workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Media #36

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Media #37

First Choice: Workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Random access slide-workbook

Media #38

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Workbook
Fourth Choice: Mediated interactive lecture

Media #39

First Choice: Workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Random access slide-workbook
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Media #40

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Workbook
Fourth Choice: Mediated interactive lecture
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Figure A-3. (continued)

Media #41

First Choice: Random access slide-workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook

Media #42

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook

Media #43

First Choice: Random access slide-workbook
Second Choice: CAI
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Media #44

First Choice: CAI
Second Choice: Random access slide-workbook
Third Choice: Mediated interactive lecture
Fourth Choice: Workbook
NOTE: Be sure you have a separate objective to teach the large memory component of this objective at the discriminated recall level.

Figure A-3. (continued)

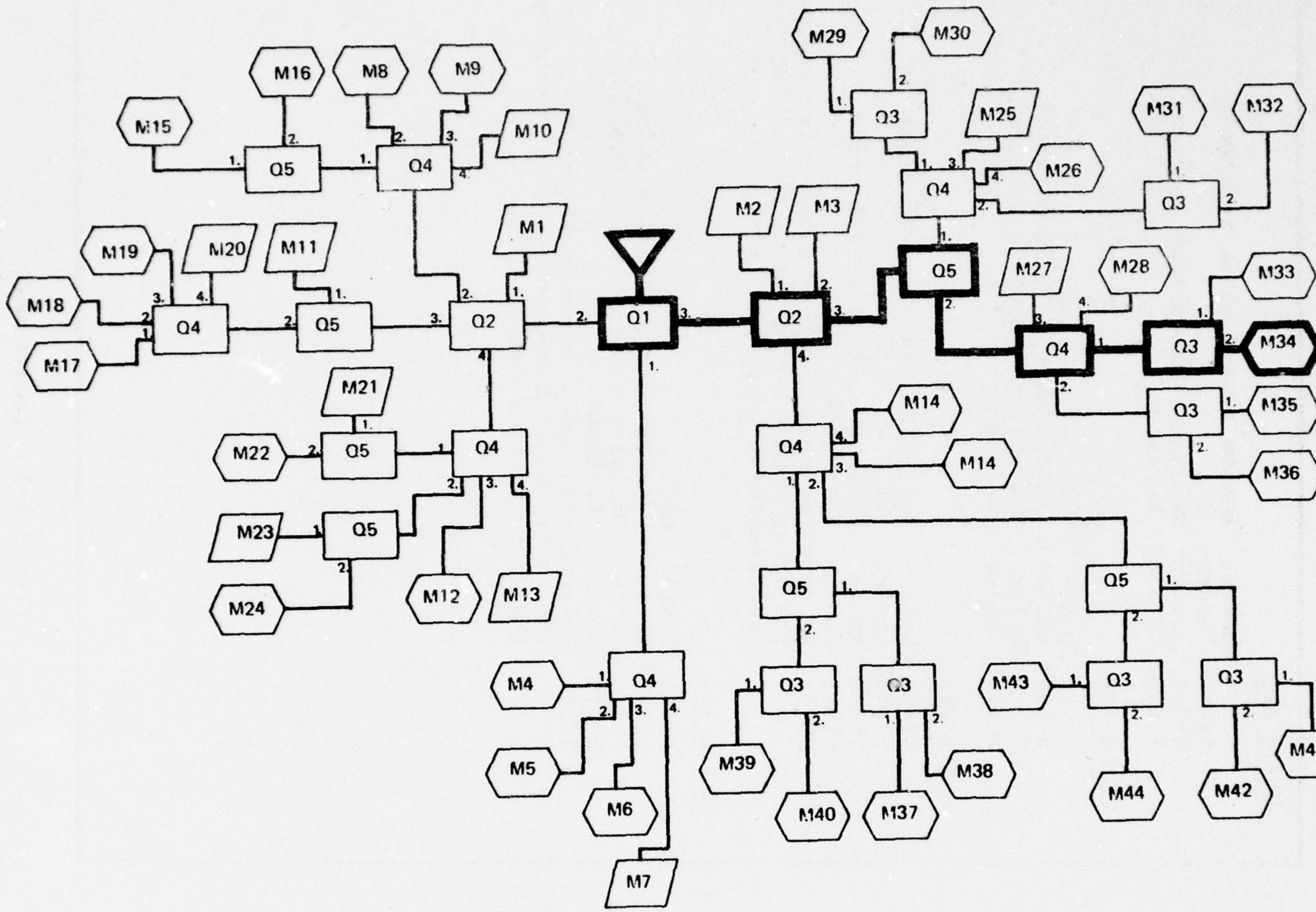


Figure A-4. An Example of How a Specific Objective is Categorized Using the Media Selection Model

TABLE A-1. MEDIA COST/TIME MATRIX

MEDIA \ TIME/COSTS		PRODUCTION TIME/COSTS					Prod. Turn-around Time	20% Re-vision Turnaround Time	Instructor Requir.	Equipment Costs	Oper. Costs
		Author	IP	SW/ED	Prod. Pers.	Total Pers.					
MIL		10	1	0	16	17	Short	Very Short	High	Very Low	None
WB	Recall	6	1	1	7	10	Moderate	Moderate			
	Concept/Rule	8	1	2	20	17	Moderate	Moderate	Moderate	None	None
ST		8	3	7	37	35	Long	Long	Moderate	Low	Very Low
RAS		13	2	3	50	41	Long	Moderate	MOderate	Low	Very Low
VT	Level 1	5	1	7	15	16	Long	Long			
	Level 2	7	1	10	18	23	Long	Long			
	Level 3	10	1	20	34	38	Long	Long	Moderate	Moderate	Moderate
	Animation	10	2	20	145	187	Very Long	Very Long			
	Home Movies	7	1	5	20	20	Moderate	Moderate Short			
CAI	Recall	8	1	0	7	14	Short	Very Short	Low	Moderate High	Moderate
	Concept/Rule	10	1	0	20	19	Moderate	Moderate	High	Very High	High
CPT or TT		10	1	0	20	19	Moderate	Moderate	High	Very High	High
WST		10	1	0	20	19	Moderate	Moderate	High	Very High	High
AC		10	1	0	20	19	Moderate	Moderate	High	Extreme High	Extreme High

TABLE A-2. NUMBER OF INSTRUCTIONAL SEGMENTS IN EACH MEDIA FOR THE FOUR MEDIA PLANS

		MEDIA PLAN 1		MEDIA PLAN 2		MEDIA PLAN 3		MEDIA PLAN 4	
		NUMBER OF SEGMENTS	% OF TOTAL	NUMBER OF SEGMENTS	% OF TOTAL	NUMBER OF SEGMENTS	% OF TOTAL	NUMBER OF SEGMENTS	% OF TOTAL
WB	Recall/ Fam	282	24	0	0	288	24	288	24
	Concept/ Rule	14	1	0	0	39	3	268	23
ST		108	9	28	2	148	12	176	15
RAC		0	0	0	0	231	20	0	0
VT	Level 1	27	2	28	2	27	2	0	0
	Level 2	30	3	0	0	30	3	0	0
	Level 3	0	0	0	0	0	0	0	0
	Animations	23	2	0	0	0	0	0	0
	Home Movie	0	0	0	0	0	0	31	3
CAI	Recall	23	2	438	37	0	0	0	0
	Concept/ Rule	256	21	270	23	0	0	0	0
CPT or PTT		73	6	71	6	73	6	256	22
WST		237	20	237	20	237	20	0	0
AC		113	10	113	10	113	10	158	13
TOTAL		1186	100%	1186	100%	1186	100%	1186	100%

TABLE A-3. SUMMARY OF RELATIVE PERSONNEL COSTS FOR DEVELOPING EACH MEDIA PLAN

CATEGORY / PLAN	DEVELOPMENT COSTS FOR PERSONNEL				
	SME Time	IP Time	Writer/Editor Time	Production Support Personnel Time	Total Personnel Cost
Media Plan 1	864	120	163	1951	2124
Media Plan 2	912	104	28	1543	1741
Media Plan 3	915	164	298	2426	2316
Media Plan 4	809	130	190	1943	1881

TABLE A-4. STAFFING REQUIREMENTS FOR MEDIA PLANS 1-4

CATEGORY	TYPE PERSONNEL	PRESENT STAFFING LEVEL	STAFFING LEVEL FOR EACH MEDIA PLAN PLAN #1	PLAN #2	PLAN #3	PLAN #4
I. Administration						
A. Officers	Officers	4	3	3	4	4
B. Intelligence Specialists	Enlisted (IS)	3	4	4	4	4
C. Secretarial	Enlisted (YN)	4	2	2	2	2
D. Graphics Support	Enlisted (DM)	4	1	1	1	1
II. Trainer Operation						
A. Maintenance Supervisors	Civil Service	3	3	3	3	3
B. Instructor/Operators	Officers	11	16	16	16	16
III. Instruction						
A. Flight Instructors	Officers	31	31	31	31	31
B. Stand-Up Instructors	Officers	7	0	0	0	0
C. Proctor-Monitors	Officers	0	4	4	7	7
IV. ISD						
A. Officers	Officers	4	7	7	7	7
B. Secretarial	Enlisted (YN)	0	5	5	5	5
C. Graphics Support	Enlisted (DM)	0	4	4	4	4
V. CAI						
A. Maintenance Personnel	Enlisted (TD)	0	1	1	0	0
B. Operators	Enlisted (unspecified)	0	1	1	0	0

Appendix B

MEDIA DEFINITIONS

Research in the fields of learning theory and instructional design has yielded a useful set of principles related to presentation requirements for maximizing instructional effectiveness. Based on these principles, the following set of essential instructional capabilities has been identified and can be used to measure the adequacy of any instructional medium. What is being said here is that any instructional sequence which purports to teach an instructional objective must have these capabilities.

Introductory Capabilities

An instructional medium must be able to present necessary introductory material to the student. Specifically, this introductory material should include expected learner outcomes, directions for the learning situation, and information which would help the student relate this lesson to other course materials.

Expository Capabilities (e.g., show, tell, demonstrate, define)

A second required instructional capability is for expository display. Expository display consists of three components: generalities, supporting explanations or "helps", and instances. A generality is a condensed statement of the critical information to be learned: the material to be memorized, the definition of a concept, or a statement of a rule. The generality gives the bright student essentially everything he needs to correctly work the practice items for the objective. A supporting explanation or "help", as its name implies, gives the student some additional related information to help him better understand the generality. The third

type of expository instruction, instances, are specific illustrative examples of a concept or specific applications of a rule. Each specific illustrative example or application must be accompanied by a "help" to ensure that the learner perceives the relationship between the example and the generality it is illustrating.

Inquisitory Capabilities (asking, practicing, testing)

A third requirement of a complete instructional medium is that it present inquisitory displays. Inquisitory displays include both practice items or exercises, and tests. In both cases, the medium must be able to present items which require the student to behave at the level specified in the objective. It must detect his response and provide feedback for it.

Flexibility and Adaptiveness Capabilities

Finally, a fully capable instructional medium must be flexible, and adaptive to student needs. This includes the ability to identify what student needs are on a display by display basis. In some cases, this may be accomplished by an approach that allows the student tc identify his own needs (learner control strategy). In other cases, the medium may do this (program control). Once learner needs have been identified, a fully capable medium should provide for them. But to do so the medium must be flexible and adaptive.

Having identified these essential instructional capabilities, it is possible to examine the range of conventional instructional methods to determine which (if any) of these capabilities are lacking. Figure B-1 presents a summary of these comparisons.

As can be seen from Figure B-1, some media handle expository instruction well but lack adequate inquisitory and flexibility capabilities. Other media provide for adequate practice and testing but do not present expository material well. However, with the exception of CAI, no media provides for all essential instructional capabilities. As a result, a modified set of instructional media has been developed to meet all basic instructional requirements. They are basically combinations and alterations of the conventional media to ensure that all requirements are met. An analysis of the basic instructional capabilities of each of these modified media is presented in Figure B-2.

Below is a detailed description of each of these modified instructional media.

1. Mediated Interactive Lecture (MIL)

As with any lecture, the major portion of the instructional material is an MIL presented verbally by an instructor to a group of students. However, as the name states a MIL must be both mediated and interactive.

A MIL requires two hard copy products, student worksheets and visual aids. The student worksheet includes a set of lesson objectives, the generalities for each objective, necessary charts, tables, and figures, and a set of practice item response sheets for each objective. The type of visual aids used in a MIL may include overhead transparencies, slides, or videotapes, depending on the display requirements of the lesson. These aids are used where appropriate to present supporting information, sets of examples, and sets of practice items.

KEY: YES / NO	BASIC OR ESSENTIAL INSTRUCTIONAL CAPABILITIES							
	Introductory Capabilities	Expository Capabilities			Inquisitory Capabilities		Flexibility and Adaptiveness Capabilities	
Conventional Instructional Methods	(Including objectives, motivation, directions, and instructional sequence relationships)	Generalities	Supporting Explanations	Instances	Practice	Test With Feedback	ID of Learner Needs	Dynamic Modification and Helps
Lecture (Expository)					PARTLY		POORLY	
Videotape or Film								
Audio-Visual					POOR			
Model								
Audiotape	FAIR			POOR				
PI Text			PARTLY				PARTLY	PARTLY
CAI								
Seminar/Discussion								PARTLY
Demonstration								
Text/Pamphlet					POOR	POOR		
Simulator								
Practical Exercise								

Figure B-1. The Ability of Conventional Instructional Methods to Provide Essentional Instructional Capabilities

KEY: YES (shaded) / NO (blank)	BASIC OR ESSENTIAL INSTRUCTIONAL CAPABILITIES							
	Introductory Capabilities	Expository Capabilities			Inquisitory Capabilities		Flexibility and Adaptiveness Capabilities	
Modified Instructional Methods	(Including objectives, motivation, directions, and instructional sequence relationships)	Generalities	Supporting Explanations	Instances	Practice	Test With Feedback	ID of Learner Needs	Dynamic Modification and Helps
Mediated Interactive Lecture (M.I.L.)	YES	YES	YES	YES	YES	YES	YES	YES
Audio-Visual or Videotape with Worksheet	YES	YES	YES	YES	YES	YES	YES	YES
Model and Worksheets	YES	YES	YES	YES	PARTLY	PARTLY	PARTLY	PARTLY
Workbook	YES	YES	YES	YES	YES	YES	YES	YES
CAI	YES	YES	YES	YES	YES	YES	YES	YES
Simulator with Worksheet	YES	YES	YES	YES	YES	YES	YES	YES

Figure B-2. The Ability of Modified Instructional Methods to Provide Essential Instructional Capabilities

In order for a lecture to be adaptive to student needs it must be interactive. An interactive lecture provides the instructor with an outline which requires him to ask the students questions and alter his presentation based on student responses.

2. Workbook

The defining characteristic of a workbook is that all instructional components are presented in printed form. Workbooks may be developed for a set of objectives that require the student to perform at a behavior level of memory only [WB (m)], or for objectives that require the student to perform at a classification or rule-using behavior level [WB (c/r)].

The organization and format of workbook ensures that all instructional components are present. The workbook begins with a lesson map, a lesson introduction, and a set of instructions explaining how to proceed. Each segment (corresponding to one objective) begins by presenting the objective, the generality and the supporting explanation or help. On the following pages a set of illustrative examples is presented for WB (c/r). Where necessary, the examples are accompanied by additional "helps". The practice items are designed to require the student to behave at the level designated in the objective. The practice set is accompanied by a feedback and help section.

3. Slide-Tape Presentation (ST)

A slide-tape presentation contains three separate components: a set of slides, a cassette audio tape, and a student worksheet. The ST presentation is normally used for recall

level objectives that require complex graphics and/or lengthy explanations.

The student worksheet first presents a lesson map, and a set of instructions about where to get the slides and the audio tape, where and how to set them up, and how best to use them. For each segment, the worksheet presents the objective, the generality, necessary charts and tables, and a response form for the practice items.

The audio tape begins with an introduction. For each objective, it restates the generality, and presents additional supporting information. The slides, of course, complement the audio tape. When working with classification and rule-using level objective, a series of examples is presented with accompanying "helps" where needed. A set of practice items is presented next. The student is told to stop the tape after each question, and write his answer on his worksheet. When the tape is started again it gives feedback and help for that item.

4. Random-Access Slide Presentation (RAS)

A random-access slide presentation contains two components: a set of slides presented via a random-access slide projector, and a student worksheet. An RAS presentation is used to present lesson material for classification and rule-using level objectives. This medium allows for visual presentation of large numbers of examples and practice items without sacrificing the freedom of movement (i.e., learner control) lost in the linear ST or VT presentation.

The worksheet in the RAS presents the lesson map, a lesson introduction, and instructions for where to obtain the slide

set, where to view it, how to set it up, and how best to use the lesson materials. For each segment, it presents the objective, the generality and some supporting explanation. It then presents tables of numbered example items and practice items. Each table presents a listing of the slide numbers of example, and help, or practice and feedback items. The student can use these tables to check those examples he has viewed, or the practice items he has worked. The practice table also provides space for the student's response.

The random-access slides are used to present an expanded version of the generality, the set of examples with helps, practice items, and feedback.

5. Videotape Presentation (VT)

A videotape presentation contains two components: a videotape cassette and a student worksheet. The use of these two components is exactly parallel to the use of corresponding components of the slide-tape presentation. The major difference between these two media is the type of display capability. The instructional strategy used is similar in both types of media.

Because the development cost for VTs can vary widely depending on the type of effect needed, five categories of VT complexity have been specified. These categories are designated VT(#1), VT(#2), VT(#3), VT(#A), VT(HM). Each of these categories will be described below:

An animated videotape [VT(A)] presents abstract concepts and ideas through the use of cartooning. This type of videotape is used when motivation is a critical requirement.

A level three videotape [VT(#3)] is the result of professional treatment for both the direction and production aspects of the process. Production techniques and features available for instructional utilization are superimposition (labeling), slow motion and special effects generation (attribute isolation), multiple fades, dissolves, wipes, special effects. music, and audio mixing. This level videotape includes full dramatization with quality acting, in total or in part from tightly written and storyboarded scripts. Essentially, this is the high content, high affect cadillac of videotape production.

A level two videotape [VT(#2)] receives a like production effort as that received by a Level 3, but dramatization is omitted. Voice-over or on-screen narration delivers content. Superimposed labels, lists, etc. are more prevalent. Motivation is carried largely through camera movement and post-production special effects generation.

A level one videotape [VT(#1)] is a one camera effort, either live action, voice-over or a mixture of this and the "big talking face" approach. Motiviation is minimal in comparison to a Level 3 or 2, i.e., special effects generation and "slick" videotape techniques available in an extensive post-production effort are reduced to more straightforward editing.

A "home movie" level videotape [VT(HM)] normally utilizes edit-in-the-camera techniques with lightweight, often hand-held portable equipment. This level is often black and white with a minimum quality lighting effect. All narration is voice-over and may be recorded along with the video.

6. <u>Computer-Assisted Instruction (CAI)</u>

The defining characteristics of computer-assisted instruction is that it presents interactive expository and inquisitory instruction through direct interface with a computer. It is distinguished from a trainer in that it is not designed for simulation purposes.

Because computers are programmable, it is possible for any hardware system to present instruction containing all basic instructional requirements outlined at the beginning of this appendix. One system which economically and efficiently fulfills all of these requirements is the TICCIT system (Time Shared Interactive Computer Controlled Television). In fact, the TICCIT system was specifically designed by instructional psychologists to meet these requirements. For this reason, the TICCIT system will be the specific CAI system described in this section. It should be noted that any CAI system which has the characteristics outlined below could be used equally as well as TICCIT.

TICCIT instruction is presented via a full color television terminal. The student interacts with the computer by means of a light pen and a special purpose keyboard. Available to a student and under his control for each objective are the following options:

Introductions

Maps

Objectives

Generalities

Examples

Practice Items

Helps

Advice

Tests

Maps, introductions and objectives fulfill the introductory requirement for a complete medium. The generalities and examples fulfill the expository requirement, and practice items and tests fulfill the inquisitory requirement. An advisor program monitors student performance and provides the student with recommendations about how he should proceed. This advisor program allows the system to be adaptive to student needs.

7. Trainer Exercise

A trainer exercise is used to allow the student to practice classification or rule-using behaviors in a simulated real world environment. The type of trainer used depends on whether cockpit motion is required, and upon the degree of fidelity to the real world required. For objectives requiring cockpit motion, a high degree of fidelity, and/or crew interaction, the Weapons System Trainer (WST) must be used. For ECMO course objectives not requiring motion, the Tactics Trainer (TT) may be used. For pilot course objectives requiring less fidelity and no motion, a Cockpit Procedures Trainer (CPT) can be used. A complete specification of the capabilities for the WST and the TT can be found in the military specification's documents for these two devices [i.e., device 2F119, and device 15E22 (mod A)]. Detailed specifications of the capabilities of the CPT can be found in Appendix E.

In addition to the obvious requirement for a trainer exercise to include the use of a trainer, it also includes three other components: a student worksheet, a student evaluation sheet and a trainer feedback sheet.

The student worksheet presents the student with the set of lesson objectives, a lesson introduction, and a set of instructions describing what he should do to be prepared for the trainer. The worksheet then presents any information the student will need for mission planning purposes, and it spells out exactly what planning he will need to have prepared. The worksheet then outlines in detail the procedures or actions the student should perform. For new procedures not previously practiced, the worksheet presents a list of steps to perform. Previously mastered procedures are referred to by name without the accompanying list of steps. In all cases, the worksheet outlines verbally or pictorially the correct result of the action.

The student evaluation sheet is used by the instructor to check the student's performance. It describes evaluation instructions, outlines necessary instructor-student interactions, and gives a checklist of all points that should be evaluated.

Based on the student's performance, the instructor fills out a trainer feedback sheet. This sheet is formatted so that the instructor can check areas where the student needs more practice. Each references course lessons which deal with the area.

8. Aircraft Flight (AC)

The instructional materials for an actual flight are similar to those for a trainer exercise. These materials include a student worksheet, a student evaluation form, and a flight feed-

back sheet. The student worksheet outlines the lesson objectives, gives the student necessary data and instructions for mission planning, and describes the general sequence of events that should occur during the flight. The student evaluation sheet, and the flight feeback sheet are the same in format as those used in the trainer exercises. The student evaluation sheet is printed on knee-cards so that it can be carried on the flight.

The information contained in this section of the Training Support Requirements Document was an appendix and is not pertinent to this report.

The information contained in this section of the Training Support Requirements Document was an appendix and is not pertinent to this report.

APPENDIX E

MINIMUM REQUIREMENTS OF A COCKPIT PROCEDURES TRAINER

Analysis of the pilot course objectives and of VAQ-129 resources indicated a definite need for a pilot/ECMO-1 Cockpit Procedures Trainer (CPT). A large proportion of the terminal pilot objectives require "hands on" behavior. With the arrival of the Weapons Systems Trainer (WST) scheduled for late 1977, the only presently scheduled available interim hands on "device" is the actual aircraft. Besides being an extremely wasteful use of an expensive resource, using the aircraft as a trainer could be dangerous to student, plane and maintenance personnel. Therefore, the production of a CPT is recommended.

While it might seem desirable for the CPT to be a functioning motionless simulator of the actual aircraft because it would be used largely for practicing emergency procedures, a device of this type would be very expensive and would require a long lead time to develop. Below is a list of the minimum requirements for the CPT, which would make it a viable interim alternative to the WST for the training of skills which can not be safely practiced in the actual aircraft.

1. The CPT must be an accurate spatial representation of the pilot and ECMO-1 seats of the EA-6B ICAP. This means that all controls and indicators must be present in the correct spatial relationship to each other, but not necessarily actual size.

2. All switches must have the same settings and/or positions available as their counterparts in the aircraft.

3. Lever controls, such as throttle, RAT, etc., must have the same settings, and range of motion, as their counterparts in the aircraft.

4. If possible, the lights and gauges listed below should function, and they should be individually controllable from an instructor station.

There should be a one-to-one correspondence between the instructor station controls and these cockpit gauges:

All caution and warning lights (46 total)
RPM, EGT, and fuel flow tapes
Hydraulic pressure gauges
Oil pressure gauges
Power trim gauges
Emergency brake gauge
Indicated position indicator
Fuel gauge

5. The tag wheels of the CCI should operate and the enter button should act as a reset of the counters to black position.

To further clarify the requirements of the CPT, the following is a list of the aircraft gauges and indicators which are not required to function. In fact, a drawing of these gauges can be substituted for the actual gauges.

Altimeters	Sync indicator
Pitot-static gauges	Canopy pneumatic gauge
AJB-3	Oxygen gauge
HSI	Doppler drift A & Gs
VGI	OAT gauge
UHF freq. repeaters	Cockpit lighting
Clock	Mag Freq. gauge on radar
PPI	ALQ-92 scope
Cabin press. gauge	Canopy handle lock
AOA gauge	Aux. canopy handle
Wet Compass	Rudder pedal adjust.
	Radar cursor slew handle

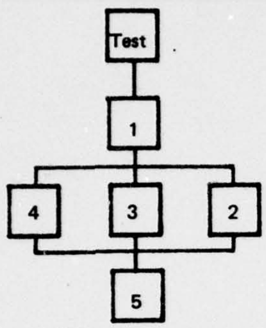
The information contained in this section of the Training Support Requirements Document was an appendix and is not pertinent to this report.

Appendix G

Lesson Specification Format Guide

I.S: Hierarchy Page

Course, Unit, Lesson P. 14.10 Title: Introduction to the Engine System



No.	Topic	Media	Testing
1.	State the normal operating limitations of the engine system.		M.
2.	Controls, indicators, and operation of the engine fuel management system.		M.
3.	Controls, indicators, and operation of the engine starting system.		M.
4.	Controls, indicators, and operation of the engine oil system.		M.
5.	Describe the normal operation of the engine system.		None

The prerequisites to this lesson are:	This lesson is prerequisite to:
None.	

1

2

P. 14.10

INTRODUCTION TO THE ENGINE SYSTEM

1. State the normal operating limitations of the engine system.
   a. Correctly state all engine designed maximum and/or minimum operational limitations as per NATOPS.

2. Locate cockpit controls/indicators and describe the operation of the engine fuel management system.
   c. Given cockpit diagram and engine system schematic.
   s. Cover input pressure and source, component transaction or operation, cockpit indicators and controls and output of the:
      A. Engine fuel control.
      B. Fuel pressure and dump valves.

3. Locate the cockpit controls and indicators, and describe the operation of the engine starting system.
   c. Given a cockpit diagram and engine system schematic.
   s. Cover input pressure and source, component transaction or operation, cockpit indicator and control, and output of the:
      A. Starter valve.
      B. Starter/CSD/generator
      C. Ignition exciter unit
      D. Ignitors

4. Locate the cockpit and indicators, and describe the operation of the engine oil system.
   c. Given a cockpit diagram and engine system schematic.
   s. Cover input pressure and source, component transaction or operation, cockpit indicator and control, and output of the:
      A. Oil tank
      B. Oil quantity indicating system.
      C. Oil pressure pump
      D. Oil filter and cooler unit.

5. Describe the normal operation of the engine system.
   c. Cut-away diagram of engine and related system components.
   s. State the names of the 4 engine related sub-system and state the function of each.

3

P. 14.10

Lesson Introduction

This is the first lesson in your syllabus. It introduces you to the engine system in the EA-6B aircraft. It will cover all of the major sub-systems, and their components. Cockpit controls and indicators for these sub-systems will also be covered. While some of the material may seem like unrelated, unimportant numbers and facts, understanding this lesson will be critical to your ability to identify and respond to engine malfunctions.

FOR EACH LESSON YOU MUST INCLUDE:

1 A Lesson Map:

This is already filled out and in the map book.

2 Lesson Objectives:

They are also finished and in the map book.

3 A Lesson Introduction:

You need to write a lesson introduction which explains to the student why he is studying this lesson. It should present a very brief overview of what the lesson is about. It should also relate the lesson to previous material, and how how this lesson fits into the big picture.

1 P. 14.10.4 2

3

Controls, Indicators, and Operation
of the Engine Oil System

Objective: Locate the cockpit controls and indicators, and describe the operation of the engine oil system.

c. Given a cockpit diagram and engine system schematic.

s. Cover input pressure and source, component transaction or operation, cockpit indicator and control, and output of the:

A. Oil tank
B. Oil quantity indicating system
C. Oil pressure pump
D. Oil filter and cooler unit

4 5

Media:

Level of Content: Fact

Level of Behavior: Recall

6

Generality:

7

The oil system on the J52 P-408 consists of the following four components (see Fig. 14.10.4.1).

1. Oil Tank. Each engine is provided with one closed self-contained oil tank which when fully serviced contains 3.4 gallons of usable oil, that is supplied directly to the oil pump. There is no cockpit control or direct indication of proper tank operation.

2. Oil Quantity Indicating System. Each oil system has its own independent quantity indicating system that receives an electrical signal from the sensor probes located in the oil tank. The measured quantity of oil is indicated in the cockpit only by means of an "Oil Low" light located on the annunciator panel (see Fig. 14.10.4.2). 8

3. Pressure Pump. The pressure pump takes oil from the tank and boosts the pressure to 35 PSI or greater, and routies it through the oil cooler to the engine. Normal operation of the oil pump in the cockpit is the oil pressure gauge located below the engine performance tapes. There is no direct cockpit control but whenever the engine is turning the pump is operating.

4. Oil Filter and Cooler Unit. Receives oil under pressure from the pump, filters and cools it and routes it to the engine. The oil is actually cooled in the fuel/oil heat transfer unit. There is no control or cockpit indications of the filter and cooler unit.

P. 14.10.4.1

FOR EACH SEGMENT WITHIN A LESSON YOU MUST INCLUDE:

1 SEGMENT DESIGNATION:

The segment designation should appear at the top of the first page for each segment. It should be in the form:

Course Letter . Unit Number . Lesson Number . Segment Number

2 TOPIC:

This should correspond verbatim with the <u>segment</u> topic on the lesson map page.

3 OBJECTIVE:

This should correspond verbatim with the segment objective given on the lesson objective page. You may want to just paste a xerox copy in the appropriate place.

4 MEDIA:

This should correspond exactly to the media given on the lesson map. If the map doesn't specify a media leave this space blank.

5 LEVEL OF CONTENT:

Work this out with the IPs.

6 LEVEL OF BEHAVIOR:

Work this out with the IPs.

7 GENERALITY:

You will have to prepare the generality for the segment. Remember, the generality is a statement:

1. of the facts to be memorized.
2. of the critical attributes of a concept.
3. of the steps or formula of a rule.

The generality should always be boxed.

8 FIGURE NUMBERS:

Figures may be referred to in the lesson specification whenever necessary. If they are, they should be properly labeled as follows:

Figure . Unit Number . Lesson Number . Segment Number . Figure Number within the segment

9

10

Help: See Fig. 14.10.4.3

Practice and testing: Require the student to fill out the matrix in the Help.. He should also locate cockpit controls and indicators.

Special teaching points: None

11

Graphics: Include these:

12

1. Fig. 14.10.4.1. Engine system diagram highlighting the 4 oil system components.
2. Fig. 14.10.4.2. Cockpit schematic highlighting oil pressure gauges.
3. Fig. 14.10.4.3. Help matrix on P. 14.10.4.3.

P. 14.10.4.2

9 HELP:

You will need to develop a help for each segment. This may take any of the following forms depending on the type of content you are dealing with:

a. Flow diagram
b. Mnemonic
c. Expanded generality (try to avoid if possible)
d. Algorithm
e. Decision tree

If the help is a figure, you can simply reference a figure number, and put the page with the diagram at the end of the specs for that segment. Also, the help should always be boxed. You may put "None" in this category if you just can't think of a useful aid. (However, consult the IP in these cases.)

10 INSTANCE SPECS OR PRACTICE AND TESTING:

Classification and rule-using level objectives will contain a section called Instance specs. A detailed explanation of what should be included in this section can be found later in this guide.

Recall level objectives should have a section labeled "Practice and Testing." You should explain the special practice or test directions. If standard procedures are to be used, indicate that. You must include practice directions for all segments, even though some segments may not be tested.

11 SPECIAL TEACHING POINTS:

You may want to specify:

1. special introductory considerations (i.e., is an advanced organizer needed).
2. special explanatory points.

If you don't have any, put "None."

12 GRAPHICS SPECIFICATIONS:

Indicate graphics which MUST be included in the segment. You may either describe the graphic or refer to an attached page where you have drawn a sketch. You should also indicate special points that you want included (e.g., "Keep it simple.", "Be sure to make individual controls legible.", "Exaggerate the ...", "Use arrow to isolate the ...").

Remember, you should number each figure you describe or refer to using this format:

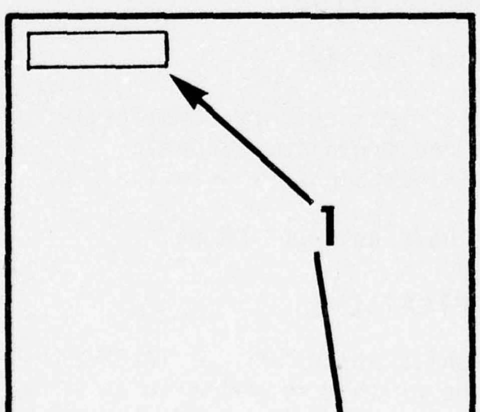
Figure . Unit . Lesson . Segment . Figure Number within that segment

1

2

Fig. 14.10.4.3

Component	Input	Operation/Output	Cockpit Control	CP Indicators/ Indicators	Operational Notes and Cautions	Normal Operating Parameters
Oil tank	3.4 gals of oil	Supplies oil to pressure pumps.	—	L&R oil low lights on annunciator panel.	—	Self-illumination=5 qts. remaining.
Oil quantity	Elect signal from	Measure oil quantity in oil tank.	—	LOX/FUEL/ OIL quantity button on mastor test panel.	Note: Oil quantity below 12.5 quarts requires servicing and should be reported to maintenance person.	Illumination test=1.2 qts. (5) remaining. No illumination on test= 12.5 qts. remaining.
Pressure	Oil from tank	Boosts oil to filter and cooling unit.	—	L&R oil pressure gauges below engine tapes.		Idle: 35 PSI Normal flight: 40 - 50 PSI
Filter and	Oil from pressure pump.	Filters and cools oil on return to tank via scavenge pump. Both units equipped with by-pass.	—	—	—	—
			P. 14.10.4.3			



ATTACHED FIGURES MUST INCLUDE:

1 THE FIGURE:

Figures may be included in either rough sketch form, or in finished form. They may also be modified xerox copies of diagrams from other parts of the course.

2 FIGURE NUMBER:

Don't forget to include a figure number. Wherever possible, a figure title or caption should also be included.

EACH PAGE MUST INCLUDE:

1 CLASSIFICATION LEVEL:

If the material is classified, you must stamp its classification level in the upper left and lower right corners of each page.

2 PAGE NUMBER:

Each page must be numbered. The number should be in the format:

Course Letter . Unit Number . Lesson Number . Segment Number . Page Number within that segment

Instance specifications:

1. Type description:
   A. Engine failure — All relevant attributes, 2 irrelevant attributes.
   B. Non-instance of A — Vary relevant attributes.
   C. Engine failure — All relevant attributes, 3-5 irrelevant attributes to include flight characteristics.
   D. Engine fire — All relevant attribures, 2 irrelevant attributes.
   E. Non-instance of D — Vary relevant attributes.
   F. Engine fire — All relevant attributes, 3-5 irrelevant attributes to include flight characteristics.
   G. Throttle linkage failure — All relevant attributes, 2 irrelevant attributes.

   H. Non-instance of G — Vary relevant attributes.
   I. Throttle linkage failure — All relevant attributes, 3-5 irrelevant attributes to include flight characteristics.
   J. Oil system failure — All relevant attributes, 2 irrelevant attributes.
   K. Non-instance of J — Vary relevant attributes.
   L. Oil system failure — All relevant attributes, 3-5 irrelevant attributes to include flight characteristics.
   M. Starter valve failure — All relevant attributes, 2 irrelevant attributes.
   N. Non-instance of M — Vary relevant attributes.
   O. Starter valve failure — All relevant attributes, 3-5 irrelevant attributes to include falight characteristics.
   P. Non-instance of engine malfunction — Vary relevant attributes — can either be normal operation or different class of malfunction.

2. Format description:
   All formatting will be of the prose type.

   Sample A:

   You are transitioning to a landing configuration and note the following conditions: airframe buffet present, airspeed is 230 knots and decreasing, altitude is 2300 feet, right FF and EGT is 100 pounds, throttles still in descent position, right generator light on, right MLG still barber poled, right oil and hydraulic gauges to zero.

   This is (choose one)
   a. a throttle linkage failure
   b. an engine failure
   c. an engine fire
   d. an oil system malfunction
   e. a starter valve malfunction
   f. none of the above.

P. 9.17.3.2

INSTANCE SPECS MUST INCLUDE:

1 TYPE DESCRIPTION:

Each type of instance to be included should be described. Each different type should be designated by capital letters. Examples and non-examples should be considered as different types. Categories of example (or non-example) should be treated as separate types. Instances requiring different display formats should also be considered as separate types.

2 FORMAT DESCRIPTIONS:

You should include a sample of the practice item format that is to be used for each type of instance. Specify which format is to be used for which types. Box each sample item to set it apart from the other material.

3

3. CEA:

The student is most likely to mix up an engine failure and a throttle linkage failure. Therefore, be heavy on those types of instances.

4 4. MCS = 1(A or C) + 1(D or F) + 1(G or I) + 1(J or L) + 1(M or O) + 1B + 1H + 1P = 8

5 5. Instance production:

TYPE	EXAMPLES	PRACTICE	TESTING (3 x MCS)
A	1		
B	1	1	3
C		2	3
D	1		
E	1		
F		1	3
G	1	1	3
H	1	1	3
I		1	3
J	1		
K	1		
L		1	3
M	1		
N	1		
O		1	3
P		1	3

6 6. Testing criteria:

One complete MCS of instances correct.

P. 9.17.3.3

3 CEA:

The instance specs. for each segment should include a Common Error Analysis (CEA). The CEA should outline the common logical errors the student is apt to make when working the practice items for that segment. If none, you should specify that.

4 MCS:

The instance specs. for each segment should specify the Minimal Critical Set (MCS) of instances the student should be required to answer correctly before you allow him to pass. It should specify number of each type of instance required. Where alternative types of instances are acceptable this should also be specified. If the ordering of the instances is not standard, this should also be specified.

5 Instance Production:

This section of the instance specs. should present a chart showing the total number of example, practice, and test items that the author must produce for each type of instance.

6 Testing Criteria:

The minimum acceptable passing criteria should be specified. This criteria should usually be one MCS worth of test items correct.

Appendix H

Sample Lesson Specifications

PILOT

Malfunction Identification and Response Generation

Objective: Identify an engine malfunction and state the proper emergency procedure.

c. Given unencountered instances of engine malfunctions, a diagram of the forward cockpit, and appropriate PCLs,

s. with 100% accuracy for all malfunctions and procedures, to include:

A. Immediate action - verbatim
B. Control response - paraphrase
C. Follow-up response - paraphrase
D. Special considerations - paraphrase

Media:

Level of Content: Concept   Level of Behavior: Classification

Generality:

> In order to properly identify an engine malfunction and generate the proper emergency procedure, do the following: (1) isolate the primary indicator, (2) determine if flight phase is critical to procedure to be selected, and (3) state the immediate action first, if any.

Help: None

Instance specs:

1. Type description:

A. Single engine failure prior to lift-off--all relevant attributes, 3 - 5 irrelevant attributes to include flight characteristics.
B. Single engine failure after lift-off--(same as A).
C. Single engine failure during climbout or mission phase--(same as A).
D. Double engine failure--(same as A).
E. Engine fire during take-off roll--(same as A).
F. Engine fire after take-off--(same as A).
G. Throttle linkage failure--(same as A).
H. Oil system failure--(same as A).
I. Starter valve failure--(same as A).
J. Non-instance of engine malfunction--very relevant attributes; can either be normal operation or different class of malfunctions.

2. Format description:

All formatting should be of the prose and picture type.

Sample:

> You have just passed the end of the runway on take-off and retracted the landing gear. Your gross weight is 53,000 lbs; Wx is M5 OVCS 2 R-240/15G25 55/53. You have the following indications on the instrument panel (see Figure 9.17.1.1: fire light, wing fuel PSI light, oxygen light).
>
> a. What malfunction, if any, do you have?:
> b. What is your immediate action, if any?:
> c. What is your control response, if any?:
> d. What is your follow-up response, if any?:
> e. What special considerations are you subject to, if any?:

3. CEA:

Because of the similarity in irrelevant attributes for identifying an engine fire as opposed to an engine failure, there is a high probability of misconception. Added practice for these two classes is suggested.

4. MCS = 1A + 2B + 1C + 1D + 1E + 2F + 1G + 1H + 1I + 1J + = 12

5. Instance production: (n = 58)

TYPE	EXAMPLES	PRACTICE	TESTING (3 x MCS)
A	1	1	3
B	1	2	6
C	1	1	3
D	1	1	3
E	1	1	3
F	1	2	6
G	1	1	3
H	1	1	3
I	1	1	3
J	1	1	3

6. Testing criteria: One complete MCS of instances correct.

Special teaching points:

1. Introductory notes:

   The purpose of this segment is to provide practice combining the identification of engine malfunctions with the generation of the appropriate response. In previous segments you learned to identify the various engine malfunctions, as well as state each corresponding emergency procedure. This segment will bring those skills together.

2. Explanatory notes: None

Graphic specs: Include one graphic.

1. Fig. 9.17.1.1. Detailed drawing of pilot's portion of forward cockpit, to include:

   a. Fire light, wing fuel PSI light, oxygen light, and master caution light all illuminated.

   b. Flight instrument readouts corresponding to flight phase situation.

PILOT

Controls, Indicators, and Operation
of the Engine Oil System

Objective: Locate the cockpit controls and indicators, and describe the operation of the engine oil system.

c. Given a cockpit diagram and engine system schematic.

s. Cover input pressure and source, component transaction or operation, cockpit indicator and control, and output of the:

A. Oil tank
B. Oil quantity indicating system
C. Oil pressure pump
D. Oil filter and cooler unit

Media:

Level of Content: Fact　　Level of Behavior: Recall

Generality:

The oil system on the J52 P-408 consists of the following four components (see Fig. 14.10.4.1).

1. Oil Tank. Each engine is provided with one closed self-contained oil tank which when fully serviced contains 3.4 gallons of usable oil, that is supplied directly to the oil pump. There is no cockpit control or direct indication of proper tank operation.

2. Oil Quantity Indicating System. Each oil system has its own independent quantity indicating system that receives an electrical signal from the sensor probes located in the oil tank. The measured quantity of oil is indicated in the cockpit only by means of an "Oil Low" light located on the annunciator panel (see Fig. 14.10.4.2).

3. Pressure Pump. The pressure pump takes oil from the tank and boosts the pressure to 35 PSI or greater, and routes it through the oil cooler to the engine. Normal operation of the oil pump in the cockpit is the oil pressure gauge located below the engine performance tapes. There is no direct cockpit control; but whenever the engine is turning, the pump is operating.

4. Oil Filter and Cooler Unit. Receives oil under pressure from the pump, filters, and cools it and routes it to the engine. The oil is actually cooled in the fuel/oil heat transfer unit. There is no control or cockpit indications of the filter and cooler unit.

Help: See Fig. 14.10.4.3

Practice and testing: Require the student to fill out the matrix in the Help. He should also locate cockpit controls and indicators.

Special teaching points: None

Graphics: Include these:

1. Fig. 14.10.4.1. Engine system diagram highlighting the four oil system components.

2. Fig. 14.10.4.2. Cockpit schematic highlighting oil pressure gauges.

3. Fig. 14.10.4.3. Help matrix.

COMPONENT	INPUT	OPERATION/ OUTPUT	COCKPIT CONTROL	CP INDICATORS/ INDICATIONS	OPERATIONAL NOTES AND CAUTIONS	NORMAL OPERATING PARAMETERS
Oil tank	3.4 gals of oil	Supplies oil to Pressure pumps.	___	L & R oil low lights on annunciator panel.	___	Self-illumination = 5 qts. remaining.
Oil quantity indicating system.	Elect. signal from sensor probe.	Measure oil quantity in oil tank.	___	LOX/FUEL/OIL quantity button on master test panel.	Note: Oil quantity below 12.5 qts. requires servicing and should be reported to maintenance person.	Illumination test = 1.2 qts. (5) remaining. No illumination on test = 12.5 qts. remaining.
Pressure pump	Oil from tank	Boosts oil to filter and cooling unit.	___	L & R oil pressure gauges below engine tapes.		Idle: 35 PSI Normal flight: 40 - 50 PSI.
Filter and cooler units	Oil from pressure pump.	Filters and cools oil on return to tank via scavenge pump. Both units equipped with by-pass.	___	___	___	___

Figure 14.10.4.3

ECMO

Response to Unreliable Present Position
(Procedure for TACAN Update)

Objective: State the procedure and locate the controls to perform a tacan update of PP.

c. Given a photograph of the CCI for reference.

s. With 100% accuracy to include:

A. Update sequence
B. Verification

Media:

Level of Content: Rule Level of Behavior: Recall

Generality:

To perform a TACAN update of PP, do the following:

A. Update sequence.

1. Identify: a. A TACAN station (signal, e.g., azimuth and DME).
   b. The latitude and longitude of the TACAN station.
2. Set and enter TACAN location as specified P. 8.9.4.
3. Adjust cursor range and bearing on PHD to match the tacan azimuth and distance. Both TACAN and PHD should agree and be relative (see Fig. 8.9.3.1).
4. Enter new adjusted site position using the radar slew ENTER button (see Fig. 8.9.3.2).

B. Verification.

Monitor the Present Position: Observe the adjustment in the PP readout as the updated turnpoint position is entered.

Help: None

Practice and testing: Provide student a diagram/photograph of CCI and direct him to generate appropriate steps in sequence along with proper verification. Provide correct answer feedback for all practice items. Student must get one complete set correct to pass.

Special teaching points: None

Graphic specs: Include the following:

1. Fig. 8.9.3.1. Photograph of PHD highlighting cursor adjustment.

2. Fig. 8.9.3.2. Photograph of CCI with appropriate controls highlighted and numbered for TACAN update.

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ECMO

Determination of Appropriate Procedure to
Update Present Position

Objective: Determine the appropriate method to update present position.

c. Given instance of NAV situations requiring update,

s. With 100% accuracy for all situations.

Media:

Level of Content: Concept

Level of Behavior: Classification

Generality:

To determine the most appropriate (reliable) method of updating present position, use the following decision checklist:

1. If there is a visible known spot available, use the visual update procedure.
2. If the known spot is not visible, but is radar significant, use the radar update procedure.
3. If the known spot is neither visible nor radar significant, use the tacan update procedure.

Help: None

Instance specs:

1. Type description:

   A. Visual update (visible known spot) - all relevant attributes, random irrelevant attributes to include one or both valid alternative update requirements met.
   B. Radar update (radar significant known spot - not visible) - all relevant attributes, random irrelevant attributes to include known tacan station.
   C. Tacan update (known spot not visible, radar insignificant) - all relevant attributes, random irrelevant attributes to include non-visibility of known spot and radar insignificance.

2. Format description:

   All instances should be of the prose type.

Sample (Type A):

On a cross-country flight, cruising in VMC at FL-220, you observe your present position readout to be somewhere close to Whidbey and you have just crossed RENO, NV. A. What procedure will you use to update the PP? B. What are the necessary steps of the update? C. How will you verify a proper update has occurred?

3. CEA: There is no predictable classification error associated with this concept.

4. MCS = 2A + 2B + 2C = 6

5. Instance production: (N = 21)

TYPE	EXAMPLE	PRACTICE	TESTING (3 x MCS)
A	2	3	2
B	2	3	2
C	2	3	2

6. Testing criteria: Student must get one complete MCS of instance correct to pass.

Special teaching points:

1. Introductory notes:

   In the previous three segments (5, 4 and 3) you have learned the three PP update procedures. The purpose of this segment is to enable you to determine the most reliable method to update the PP.

2. Explanatory notes: None

Graphic specs: None